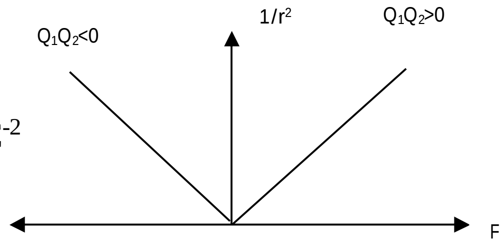
1. ELECTROSTATICS

GIST

- Electrostatics is the study of charges at rest.
- The intrinsic property of fundamental particle of matter which give rise to electric force between objects is called charge.
- Charging a body can be done by friction, induction and conduction.
- Properties of charges:
  - Like charges repel and unlike charges attract.
  - Charges are additive in nature i.e., $Q=\sum_{i=1}^{n} q_i$
  - Charges are quantized. i.e., $Q= \pm ne$ [n=1,2,3,… & e =1.602 X10^{-19} C]
  - Charge on a body is independent of velocity of the body.
  - Charge is conserved.
- The sensitive device which is used to identify whether the body is charged or not is called electroscope.
- Coulomb's law: $\vec{F} = \frac{kq_1q_2}{r^2}\hat{r}$;

  $k=\frac{1}{4\pi\epsilon_0}$ = 8.988 x 10^9 OR 9 x 10^9 Nm^2C^{-2}



ϵ_0= absolute permittivity of free space.

ϵ_0 = 8.855 x 10^{-12} OR 9 x $10^{-12}C^2N^{-1}m^{-2}$.

- The charge is said to be one coulomb when it is separated from similar charge by one-meter experiences a force of repulsion 9 x 10^9 N.
- The period of revolution of charge q_1 of mass m about charge q_2 along the circular path of radius r is $T = \sqrt{\frac{16\pi^3\epsilon_0 m r^3}{q_1q_2}}$
- Principle of superposition: $\vec{F}_{total} = \sum_{i=1}^{n}\vec{F_i}$[Vector sum of individual forces]

$$=\frac{1}{4\pi\varepsilon_o}\frac{q_1q_2}{r_{12}^2}\hat{r}_{12}+\frac{1}{4\pi\varepsilon_o}\frac{q_1q_3}{r_{13}^2}\hat{r}_{13}+....$$

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

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

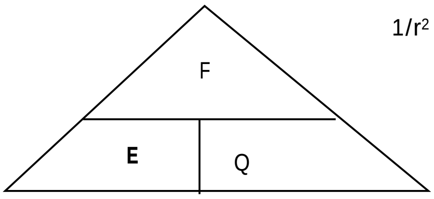
  Surface charge distribution: $\sigma = \frac{\Delta q}{\Delta S}$ [$\sigma \Rightarrow$ surface charge density Unit Cm^{-2}]

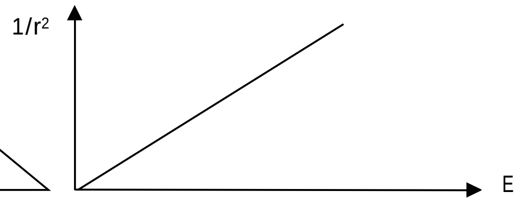
  Volume charge distribution: $\rho = \frac{\Delta q}{\Delta V}$ [$\rho \Rightarrow$ Volume charge density Unit Cm^{-3}]

- Force due to continuous charge distribution:

$$\vec{F} = \frac{q_o}{4\pi\epsilon_0}\left[\int_L \frac{\lambda dl}{r^2} + \int_S \frac{\sigma dS}{r^2} + \int_V \frac{\rho dV}{r^2}\right]\hat{r}$$

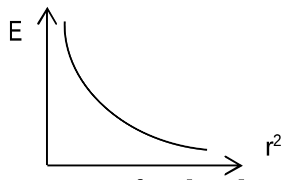
- The comparison of electrostatic and gravitational forces between electron and proton is $\frac{F_e}{F_g} = \frac{ke^2}{Gm_pm_e}$= 2.27 x 10^{39}.





Note: *In the above triangle the quantity shown at the vertex, could be arrived by multiplying the quantities shown at the base, i.e. 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 charge. It is a vector. SI unit is NC^{-1}. $\vec{E} = \underset{q_o \to 0}{Lt} \frac{\vec{F}}{q_o}$



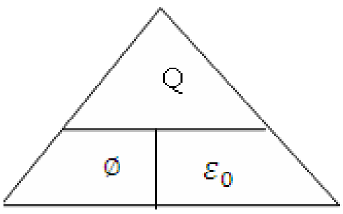
- Field due to a point charge Q at r is $\vec{E} = \frac{kQ}{r^2}\hat{r}$
- Principle of superposition: $\vec{E}_{total} = \sum_{i=1}^{n} \vec{E_i}$ [vector sum of individual fields]
- Electric field due to continuous charge distribution:

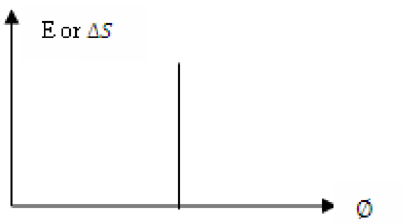
$$\vec{E} = \frac{1}{4\pi\epsilon_0}\left[\int_L \frac{\lambda dl}{r^2} + \int_S \frac{\sigma dS}{r^2} + \int_V \frac{\rho dV}{r^2}\right]\hat{r}$$

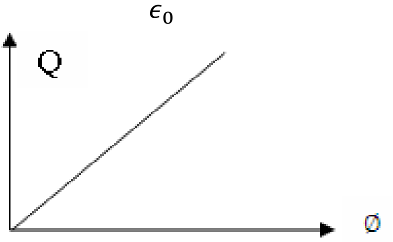
- Dipole: Two equal and opposite charges separated by a small distance.
- Dipole moment: Product of magnitude of either charge and distance of separation between them. It is a vector. SI unit: Cm, $\vec{p}$= (Q) $2\vec{a}$; direction of $\vec{p}$ is from negative charge to positive charge along the straight line joining both the charges.
- Dipole in a uniform electric field experiences no net translating force but experiences a torque. $\vec{\tau}=\vec{p} \times \vec{E} \Rightarrow \vec{\tau}=|\vec{p}||\vec{E}| \sin\theta\, \hat{n}$
- If θ= 0° ⇒ stable equilibrium; If θ= 180° ⇒ unstable equilibrium.
- Electric field due to a short dipole

- o <u>at a point on the axial line</u>: $E_{axial} = \frac{2k\vec{p}}{r^3}$ along the direction of dipole moment
- o <u>At a point on the equatorial line</u>: $E_{eq} = \frac{k\vec{p}}{r^3}$ opposite to the direction of dipole moment.

- Properties of electric field lines:
  - ✓ Arbitrarily starts from +ve charge and end at –ve charge
  - ✓ Continuous, without any breaks, never form closed loops
  - ✓ Never intersect
  - ✓ Relative closeness of the field lines represents the magnitude of the field strength.
  - ✓ For a set of two like charges – lateral pressure in between
  - ✓ For a set of two unlike charges – longitudinal contraction in between.
- Area vector: The vector quantity representing the area of a surface whose magnitude is equal to the magnitude of the area and direction is perpendicular to the surface.
- Electric flux: $\emptyset = .\vec{E}.\overrightarrow{\Delta S} = |\vec{E}||\overrightarrow{\Delta S}|cos\theta$; It is a scalar; SI unit: N m^2C^{-1} or Vm.
- Gauss' theorem in electrostatics: $\emptyset_{total} = \oint_S \vec{E}.\overrightarrow{dS} = \frac{q_{total}}{\epsilon_0}$







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

- Applications of Gauss' theorem for uniform charge distribution:

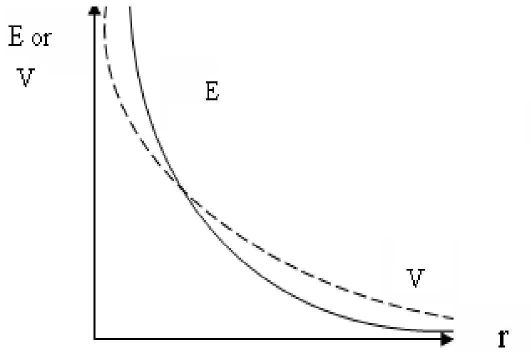
Expression for	**Infinite Linear**	**Infinite plane sheet**	**Thin spherical shell**
Flux ∅	$\frac{\lambda l}{\epsilon_0}$	$\frac{\sigma S}{\epsilon_0}$	$\frac{\sigma 4\pi r^2}{\epsilon_0}$
Magnitude of Field E	$\frac{\lambda}{2\pi r\epsilon_0}$	$\frac{\sigma}{\epsilon_0}$	$\frac{Q}{4\pi r^2\epsilon_0}$[for points on/outside the shell] ZERO [for points inside the shell]
Charge density	$\lambda = \frac{\Delta q}{\Delta l}$	$\sigma = \frac{\Delta q}{\Delta S}$	$\frac{\sigma}{4\pi r^2}$

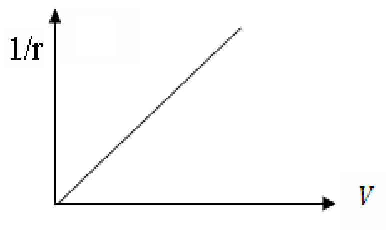
- Electrostatic Potential: Work done per unit positive Test charge to move it from infinity to that point in an electric field. It is a scalar. SI unit: J/C or V

$$V = W / q_o$$

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

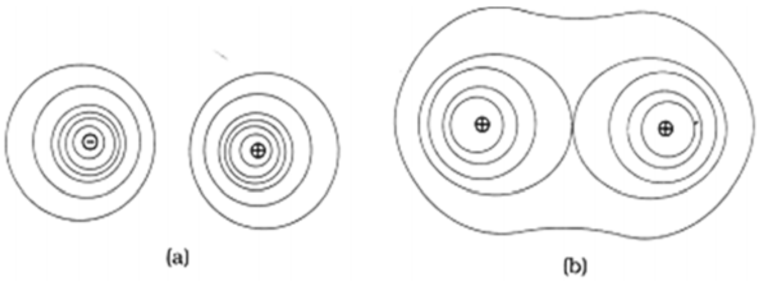
- The electrostatic potential at any point in an electric field is said to be one volt when one joule of work is done in bringing one unit charge from infinity to that point.
- The electric field intensity at any point is the negative gradient of potential at that point. $E = -dV/dr$. $V(\vec{r}) = -\int_{\infty}^{r} \vec{E} . \overrightarrow{dr}$
- As E= - $\frac{dV}{dr}$ If Vis constant, E$\propto \frac{1}{r}$ and if E is constant, V$\propto r$





- 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 = $\frac{kq_1q_2}{r}$
- Potential energy of a dipole : U = $-\vec{p}.\vec{E}$ = p E $[cos\theta_1 - cos\theta_2]$
- 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.
- ✓ The relative density of equipotential surface gives intensity of electric field in that region.

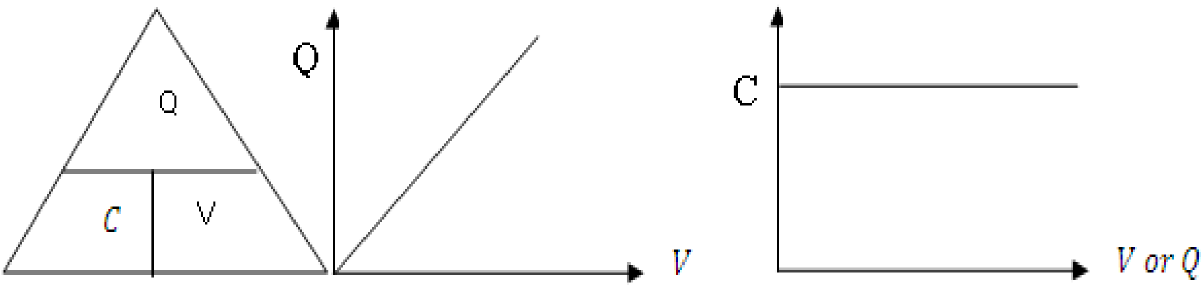


Some equipotential surfaces for (a) a dipole, (b) two identical positive charges.

- Electrostatics of conductors

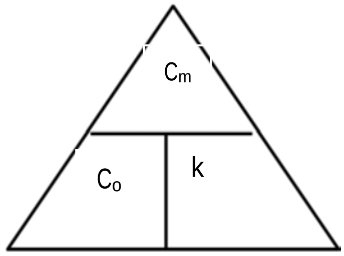
(i) Inside a conductor Electrostatic field is zero
(ii) On the surface E is always Normal to the surface
(iii) No excess charge resides inside the conductor
(iv) Charge distribution on the surface is uniform if the surface is smooth
(v) Electric field is zero in the cavity of hollow conductor and potential remains constant which is equal to that on the surface.

- Capacitor: An arrangement of two conductors separated by a small distance without any electrical contact between them is called capacitor.



- Capacitance: $C = \frac{Q}{V}$, Ratio of charge and potential difference. Scalar. SI unit: farad [F]. The capacitance is said to be one farad when one coulomb of charge increases the potential difference between the plates by one volt.
- Capacitance of a parallel plate capacitor: $C = \frac{\epsilon_0 A}{d}$

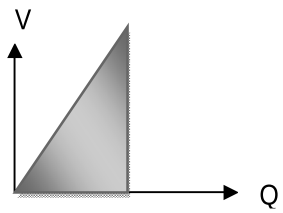
- Capacitance of a parallel plate capacitor with a dielectric medium in between:
  - $C_m = \frac{\epsilon_o A}{\left(d-t+\frac{t}{k}\right)}$
  - If t=0 =>$C_0 = \frac{\epsilon_o A}{(d)}$
  - If t=d =>C_0 =k $\frac{\epsilon_o A}{(d)}$ =>C_m = k C_0



- Combination of capacitors:

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

- Energy stored in capacitors: $U = \frac{1}{2}CV^2 = \frac{1}{2}QV = \frac{1}{2}\frac{Q^2}{C}$
- Area shaded in the graph = U $= \frac{1}{2}QV$
- Energy density : $U_d = \frac{1}{2}\epsilon_0 E^2 = \frac{\sigma^2}{2\epsilon_0}$



- The total energy in series and parallel combinations of capacitors is additive.
- When two charged conductors are touched mutually and then separated the redistribution of charges on them is in the ratio of their capacitances.
- 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 $\frac{1}{2}\epsilon_0 E^2$[Energy is supplied By battery]	1/K times $\frac{1}{2}\epsilon_0 E^2$[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: $\Delta U = \frac{1}{2}\frac{C_1 \times C_2}{C_1+C_2}(V_1 - V_2)^2$
- The dielectric is the substance which is essentially an insulator but behaves like a conductor in electrostatic situation.
- The dielectric having atom or molecules whose negative charge centre is not coinciding with positive charge centre is called polar dielectric. They have permanent dipole moments in the order of 10^{-30} Cm.
- The dielectric having atom or molecules whose negative charge centre is coinciding with positive charge centre is called non-polar dielectric.
- The dipole moment developed in non-polar dielectric due to external electric field is called induced dipole moment.
- The induced dipole moment per unit volume is called Polarisation Vector. The direction of polarisation vector is same as that of external electric filed.
- The ratio of electrostatic force in free space to that in medium OR the ratio of electrostatic field in free space to that in medium OR the ratio of absolute permittivity of medium to that of free space is called relative permittivity or dielecric constant of the medium. $\epsilon_r OR \kappa$.
- The ratio of polarisation to ϵ_o times the electric field intensity is called electric susceptibility. $\chi = \frac{P}{\epsilon_o E}$. The dielectrics with constant χ are called linear dielectrics.
- The maximum external electric field the dielectric can withstand without dielectric beakdown is called dielectric strength. SI unit Vm^{-1}.
- The capacitance of a spherical conductor of radius R is C = $4\pi\epsilon_o R$.

CHARGES AND COULOMB'S LAW

QUESTIONS

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 i.e., $Q = n \times e$
3. What is meant by electrostatic shielding? Ans: Electric filed inside a cavity is zero. 1
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
   (i) Can never intersect one another? 1
   (ii) Cannot form closed loops?
   Ans : Because
   (i) The direction of Electric field is tangential to field line at any given point. Hence at the point of intersection there will be two tangential directions for two lines. But Electric field is a vector quantity and it can have only one direction at a point. So intersection of field lines is not possible.
   (ii) Electric field lines always start from positive charge and end at negative charge. Hence they can not form closed loops.
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 Vacuum?

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°. if they are released, what is the kinetic energy of each proton when at infinite separation. [Hint : at infinite 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 $\vec{E} = 10^4 \hat{\imath} NC^{-1}$. How much is the flux passing through an area 'A' if it is a part of XY plane, XZ plane, YZ plane, making an angle 30^0 with the axis? 2

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

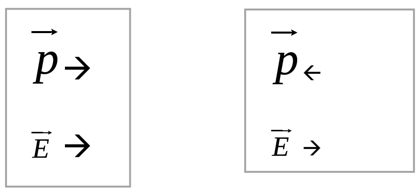
13. An electric dipole ±4μC is kept at co-ordinate points (1, 0, 4) are kept at (2,-1, 5), the electric field is given by $\vec{E}$ = 20 $\hat{\imath}$ NC^{-1}. Calculate the torque on the dipole. 2

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

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

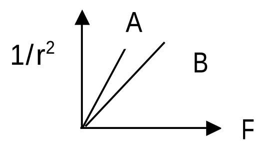
14. Show diagrammatically the configuration of stable and unstable equilibrium of an electric dipole ($\vec{p}$) placed in a uniform electric field ($\vec{E}$). 2

Ans:



Stable Unstable

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



[Hint : graph can be drawn choosing –ve axis for force only]
Ans: $|\vec{F_B}| > |\vec{F_A}|$

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: $\Phi = \frac{\lambda l}{\epsilon_0}$

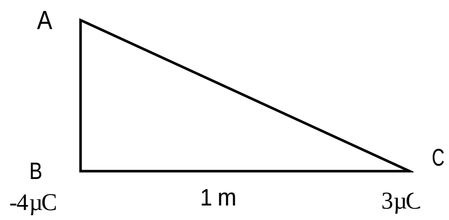
17. Calculate the force between two alpha particles kept at a distance of 0.02mm in air. 2
Ans: $\boldsymbol{F = 9 \times 10^9 \frac{4\times(1.6\times10^{-19})^2}{(2\times10^{-5})^2}}$ **N**

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: $E=45\times10^3$ NC^{-1}
$\theta=36.9°$ from line AB



21. A sensitive instrument is to be shifted from a strong electric field in its environment. Suggest a possible way. 2
[Hint : Electrostatic shielding]

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

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

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

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

Ans: $\emptyset = \vec{E}.\vec{S} = Q/\varepsilon_0$ $E \times 4\pi r^2 = Q/\varepsilon_0$ 3

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

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

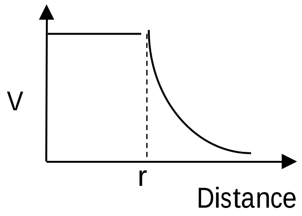
Ans: Statement $\int \overline{E}.\overline{ds} = \frac{q}{\varepsilon_o}$ Derivation for $E = \frac{\lambda}{2\Pi\varepsilon_o r}$

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

ELECTRIC POTENTIAL

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

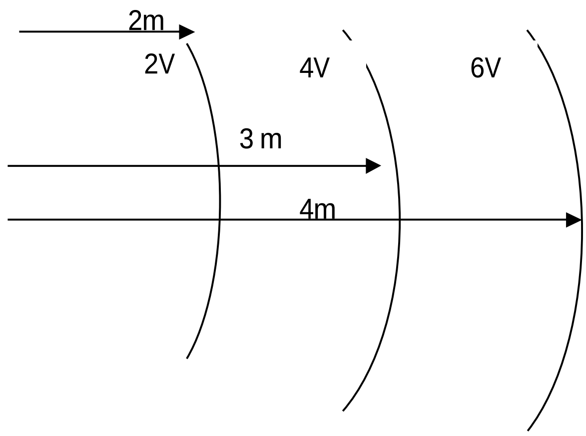
Ans



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

Ans: 6 : 1

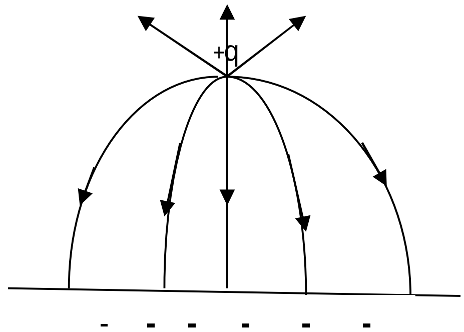
9. Calculate the electric field from the equipotential surface shown below. 1



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

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

Ans



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

Ans: (0,0,2)-q ……………. +q(0,0,-2)

-15 μc +15 μc

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

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

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

Ans: Charge lies on the surface of a conductor only

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

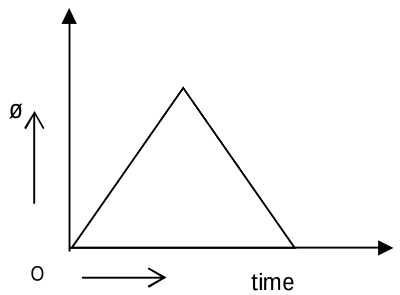
Ans: $(Q_1 – Q_2)/2C$

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

Ans: [3:1]

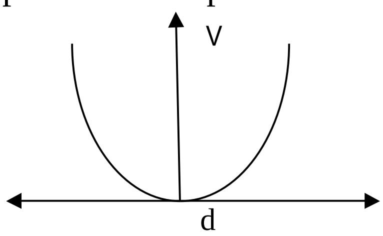
16. A uniformly charged rod with linear charge density λ of length L is inserted into a hollow cubical structure of side 'L' with constant velocity and moves out from the opposite face. Draw the graph between flux and time. 2

Ans



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

Ans 2



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

Ans: 200 unit

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

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

20. The spherical shell is **to** be charged to a potential of 2 million volt. 2

Calculate the minimum radius the shell can have, if the dielectric strength of air is 0.8 kV/mm.

Ans: [2.5m]

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

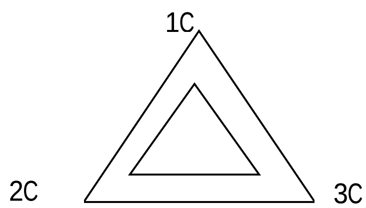
Ans: 5 in parallel and 2 in series

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

Ans: 5.56 x 10^{-23}m

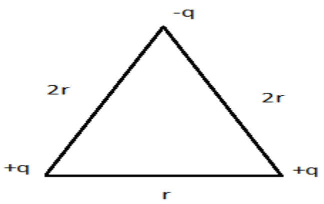
23. Three point charges of 1C, 2C & 3C are placed at the corners of an equilateral triangle of side 1m. Calculate the work done to move these charges to the corners of a smaller equilateral triangle of sides 0.5m. 2

Ans: 9.9 x 10^{10} J

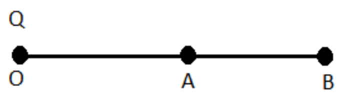


2

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



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



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

CAPACITORS

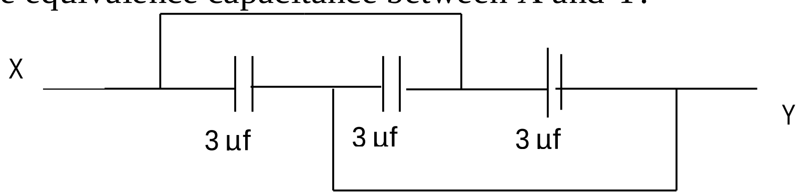
1 What happens to the capacitance of a capacitor when a copper plate of thickness one third of the separation between the plates is introduced in the capacitor? 2

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

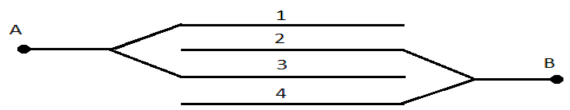


Ans: 9 µf

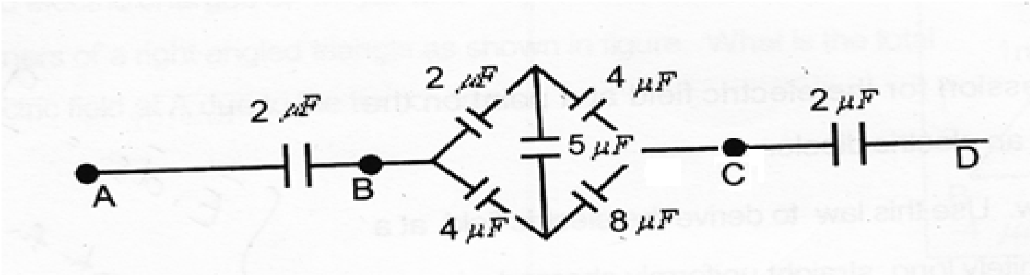
4 A pith ball of mass 0.2 g is hung by insulated thread between the plates of a capacitor of separation 8cm. Find the potential difference between the plates to cause the thread to incline at an angle 15^0 with the vertical, if the charge in the pith ball is equal to 10^{-7}C. 2

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

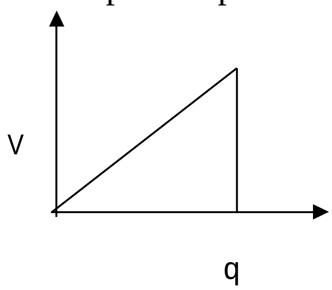
9. A potential difference of 1200 V is established between two parallel plates of a capacitor. The plates of the capacitor are at a distance of 2 cm apart. An electron is released from the negative plate, at the same instant, a proton is released from the +ve plate. 3

(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 Am^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 3

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.
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 $\varepsilon r=4$. 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

- Electric current is defined as the amount of charge flowing through any cross section of the conductor in unit time. The rate of flow of chrge through the conductor is called electric current. $I = Q/t$. SI Unit Ampere (A).
- The electric current flowing through the conductor is said to be one ampere when one coulomb charge flows through it in one second.
- Current density $|\vec{J}| = I/A$.
- Ohm's law: The electric current passing through a conductor is directly proportional to the potential difference applied across it provided the physical conditions such as temperature, pressure etc., remain constant. $V \alpha I$ i.e. $V = IR$, Where R is the resistance of the conductor. Resistance R is the ratio of V & I
- The device which opposes the flow of electric current through it is called resistor. Resistance is the characteristic property of the conductor which offers opposition for the flow of electric current.
- Resistance $R = \rho l/A = ml/ne^2\tau A$ 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 is the characteristic property of the material which is the resistance of the conductor of unit length and unit area of cross section.
- Resistivity $\rho = m/ne^2\tau$, Where m, n, e are mass, number density and charge of electron respectively, τ-relaxation time of electrons. ρ is independent of geometric dimensions.
- Relaxation time is the average time interval between two successive collisions
- Conductance of the material G =1/R and conductivity σ=1/ρ
- Drift velocity is the average velocity of all electrons in the conductor which drift in opposite direction to the applied electric field. Drift velocity $V_d = (eE/m)\tau$ also $I = neAv_d$
- Mobility (μ) of a charge carrier is the ratio of its drift velocity to the applied electric field $\mu = \frac{V_d}{E}$
- Effect of temperature on resistance: Resistance of a conductor increase with the increase of temperature of conductor $R_T = R_0(1+\alpha T)$, 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: $R_{series} = R_1 + R_2 + ...R_n$, $\frac{1}{R_{Parallel}} = \frac{1}{R_1} + \frac{1}{R_2} + ...\frac{1}{R_n}$
- Colour coding :

Black	**B**rown	**R**ed	**O**range	**Y**ellow	**G**reen	**B**lue	**V**iolet	**G**ray	**W**hite
0	1	2	3	4	5	6	7	8	9

<u>Tolerance</u> (i) Gold 5% (ii) Silver 10% (iii) No Color 20%

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

- 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 potential difference between its ends in a closed circuit.
- Internal resistance *r* of a cell is defined as the opposition offered by the cell to the flow of current. r = $\left(\frac{E}{V} - 1\right)R$ where R is external resistances.
- Grouping of cells :

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

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

- Kirchhoff's Rule:

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

ii) Loop rule:-The algebraic sum of potential differences and emfs of a closed loop in a network 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, $\frac{P}{Q} = \frac{R}{S}$
- Wheatstone bridge is most sensitive when the resistance in the four arms are of the same order
- In the balanced condition of the bridge on interchanging the positions of galvanometer and battery if there is no effect on the balancing length of the bridge.
- The principle of Metre Bridge: The resistance of the wire of uniform cross section and composition is directly proportional to its length.

- Slide Wire Bridge or Metre Bridge is based on Wheatstone bridge and is used to measure unknown resistance. If unknown resistance S is in the right gap, $s = \left(\frac{100 - l}{l}\right)R$
- Potentiometer is considered as an ideal voltmeter of infinite resistance.
- Principle of potentiometer: The potential drop across any portion of the wire of uniform cross section and uniform composition is proportional to the length of that portion of the wire provided steady current is maintained in it i.e. $v \alpha l$
- Smaller the potential gradient greater will be the sensitivity of potentiometer.
- 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 is given by r=$\left(\frac{l_1 - l_2}{l_2}\right)R$, 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 $\frac{\varepsilon}{r + R} * \frac{rl}{L}$. 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 by the source 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 total work done by the source in maintaining the current in an electrical circuit for a given time. Electrical energy = $VIt = I^2Rt = (V^2/R)t = Pt$
- Commercial unit of energy 1KWh= 3.6×10^6J

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: $V_{dx}/V_{dy} = n_y/n_x = 1/2$

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

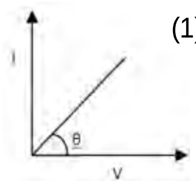
4. Can the terminal potential difference of a cell exceed its emf? Give reason for your answer. (1)

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

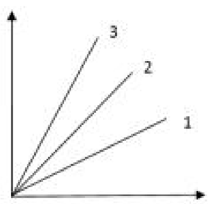
7. It is found that 10^{20} electrons pass from point X towards another point Y in 0.1s. How much is the current & what is its direction? (1)

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 o fA. If the resistance of A and B are denoted by R_A and R_B, find R_A/R_B. (1)

Ans: 1

I



1. The V-I graph of two resistors in their series combination is shown. Which one of these graphs shows the series

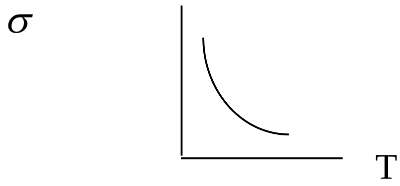
(1)

combinations of the other two? Give reason for your answer.

Ans: 1

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

(Ans: see fig1)



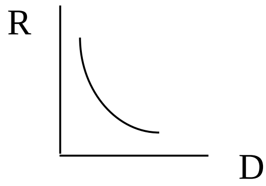


Fig 1 **fig2**

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. (2)

(Ans: see fig2)

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: $I \alpha n v_d$ i.e. $V_{dx}/V_{dy} = n_y/n_x = ½$) (2)

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)

Ans: $R = 60 \times 10^4 \Omega$, $I = 5 \times 10^{-5}$ A

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: $I = q/t = q\omega/2\pi$.

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

(2)

the specific resistance of the constantan wire is 30 times than that of the silver?

Ans: 40Ω

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

(2)

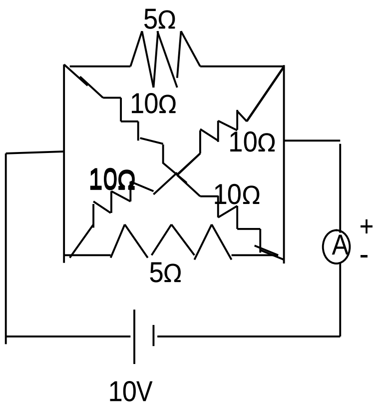


Fig 1.

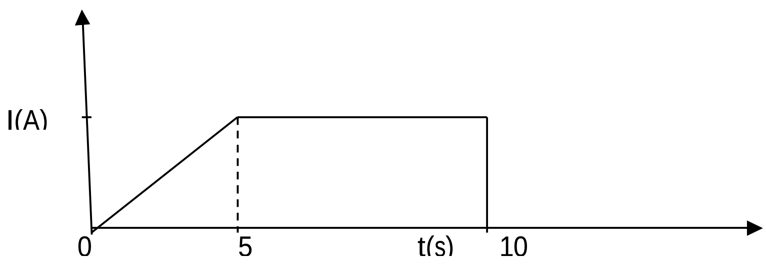


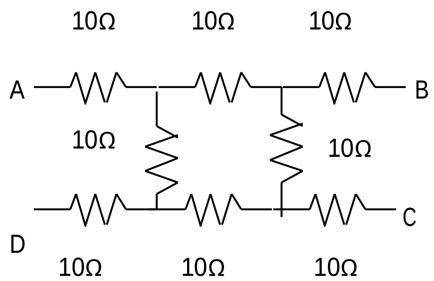
Fig 2.

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)

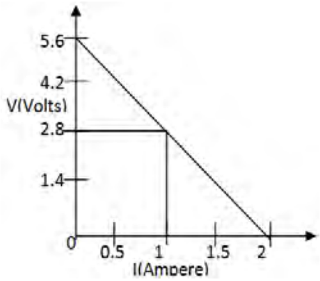
Ans: $R = \rho l/A = 4\rho l/\pi d^2$ $R_A/R_B = 9/8$ $V_A/V_B = I_A R_A / I_B R_B = 9/8$

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. (3)

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

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

(iii)Calculate the internal resistance of each cell



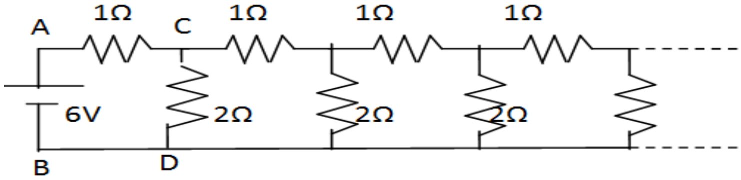
Ans: 4E = 5.6 E = 1.4 V

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

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

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

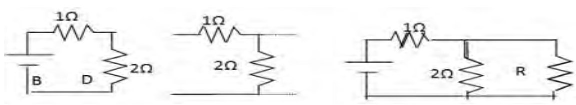
23. An infinite ladder network of resistances is constructed with 1Ω and 2Ω resistances shown. (3)



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

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

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

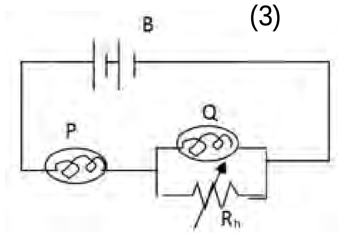


$R = \frac{2R}{R+2} + 1$ $R = 2\Omega$

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$^0C^{-1}$ 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 (3)

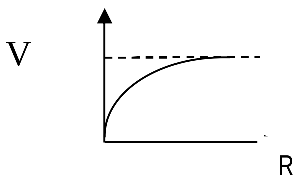
Ans: (a) $I = \varepsilon / (r + R)$ (3)

$I = I_{max}$ when $R = 0$ $\quad I_{max} = \varepsilon / r$

(b) $V = \varepsilon R/(r + R) = \varepsilon /(r/R + 1)$

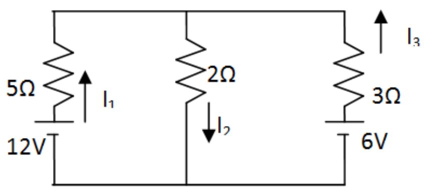
$V = V_{max}$ when $r/R + 1 =$ minimum, $r/R = o$, $V = \varepsilon$

(c)



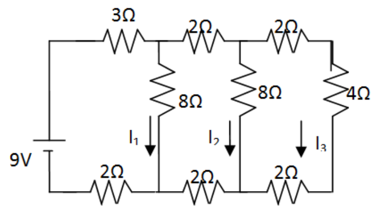
II. KIRCHHOFF'S RULE AND APPLICATIONS

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



Ans: $I_1 = 48/31A$ $\quad I_2 = 18/31A$ $\quad I_3 = 66/31A$ (3)

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



Ans: I = 1A

III. WHEATSTONE BRIDGE AND POTENTIOMETER

1. The emf of a cell used in the main circuit of the potentiometer should be more than the potential difference to be measured. Why? (1)
2. The resistance in the left gap of a metre bridge is 10Ω and the balance point is 45cm from the left end. Calculate the value of the unknown resistance. (1)

Ans S = 12.5Ω

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 (2)

   i) Position of cell and Galvanometer are interchanged?

   ii) Position of the known and unknown resistances is interchanged?

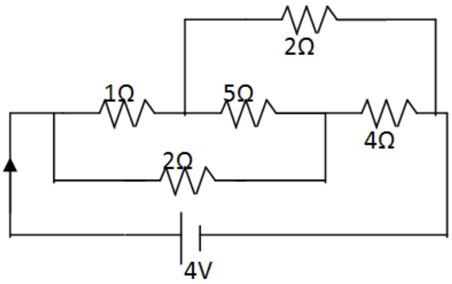
7. Explain with a neat circuit diagram, how will you compare emf of two cells using a potentiometer?

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)

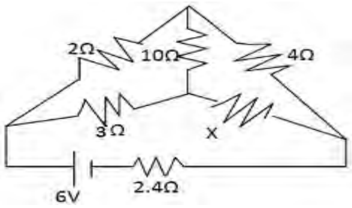
10. Calculate the current drawn from the battery in the given network.

Ans: I = 2A

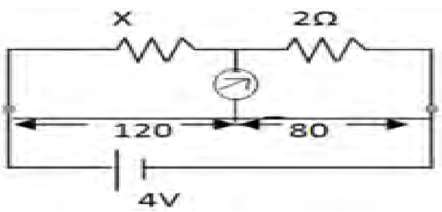


11. Find the value of X and current drawn from the battery of emf 6V of negligible internal resistance (3)

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)

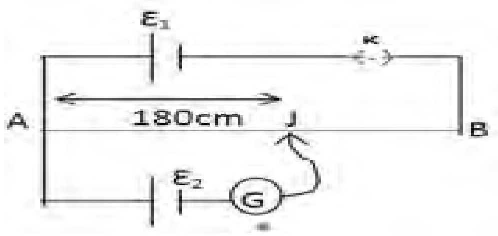


Ans: X = 3Ω

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)

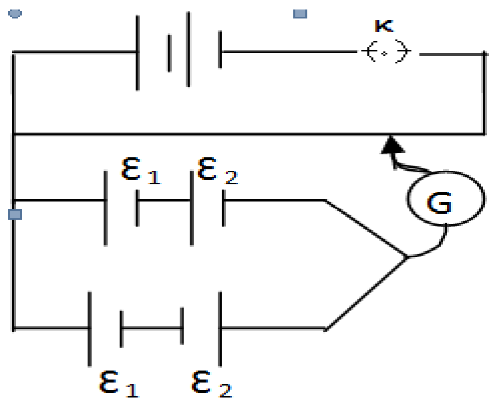
(a)If the galvanometer G shows zero deflection, what is the emf ε_1 of the cell used?

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



Ans: (a) PD V_{AB} = 1.8 V (b) Balance pt. will shift towards B since V/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 ε_1 and ε_2 are connected in series as shown in the combination (1) and (2). The balance points are obtained respectively at 400cm and 240cm from the point A. Find (i) $\varepsilon_1/\varepsilon_2$ and (ii) balancing length for the cell ε_1 only. (3)

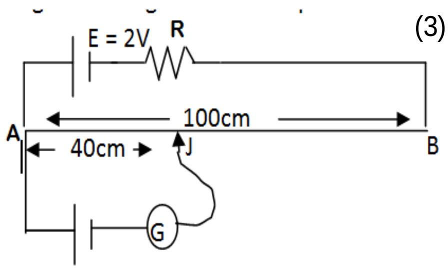


Ans : $\varepsilon_1 + \varepsilon_2 \propto 400$, $\varepsilon_1 - \varepsilon_2 \propto 240$,Solving

$\varepsilon_1/\varepsilon_2 = 4$, $\varepsilon_1 \propto l_1$,

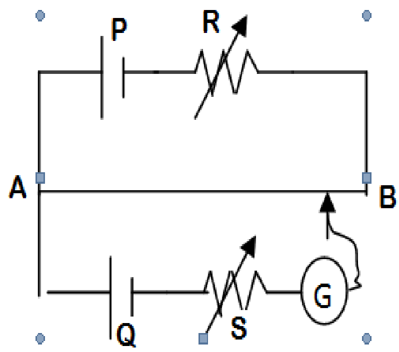
$(\varepsilon_1 + \varepsilon_2)/\varepsilon_1 = 400/l_1$, $l_1 = 320cm$

15. A potentiometer wire of length 100cm having a resistance of 10Ω is connected in series with a resistance and cell of emf 2V of negligible internal resistance. A source emf of 10mV is balanced against a length of 40cm of potentiometer wire. What is the value of the external resistance? (3)



Ans: $I = E/(R + 10) = (2/R + 10)$ Resistance of 40cm wire is 4Ω. At J, $(2/R + 10) \times 4 = 10 \times 10^{-3}$ R = 790Ω

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



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

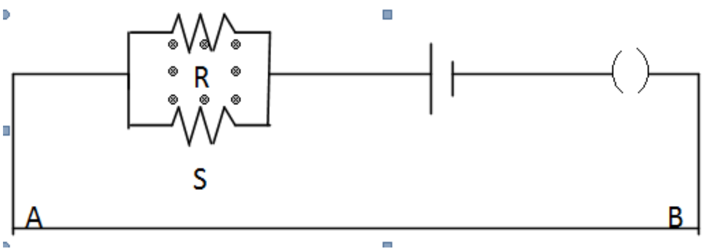
(ii) Resistance S is increased keeping R constant.

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

Ans: (i) As R is increased V/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 $I = E/ (R_0 + (RS/R+S))$

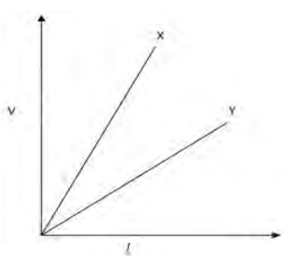
Total potential difference across AB $V = I R_0 = E R_0/ (R_0 + (RS/R+S))$

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.

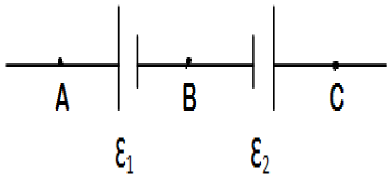
<u>Precaution:</u> Positive terminal of the test cell must be connected to positive terminal of the battery.

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



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

19. Two cells of emfs ε_1 and ε_2 ($\varepsilon_1 > \varepsilon_2$) are connected as shown in figure When a potentiometer is connected between A and B, the balancing length of the potentiometer wire is 300cm. On connecting the same potentiometer between A and C, the balancing length is 100cm. Calculate the ratio of ε_1 and ε_2. (3)



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?

Ans: $R = V^2/P$, $R \alpha 1/P$, 60 lamp has more resistance (1)

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.

Ans: $P = I^2R$ $P \alpha R$ Heat produced is higher in Nichrome wire. (2)

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

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

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

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

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

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

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

(I) a wet body and

(II) a dry body.

When will we have serious consequences dry skin or wet skin? Why?

3.MAGNETIC EFFECTS OF CURRENT AND MAGNETISMGIST

- Magnetic field: The region around a magnet or current carrying conductor with in which it influences other magnets or magnetic material. SI unit of magnetic field intensity is Tesla (T).
- Biot-Savart Law: $dB = \mu_0 \mathbf{I} dl Sin\theta / 4\pi r^2$ where $\mu_0 = 4\pi \times 10^{-7}$ Tm/A. [Direction of dB can be found by using Maxwell's Right hand thumb rule.]
- Applications:

Magnetic field at the centre of a current carrying circular coil is $B = \mu_0 I/2a$.
Magnetic field at a point on the axis of current carrying coil is $B = \mu_0 Nia^2/2(a^2+x^2)^{3/2}$ (N=no. of turns in the coil)

- Ampere's circuital law: It states that the line integral of magnetic field around any closed path in free space is μ_0 times the total current passing through the area of loop. $\oint \vec{B}.\vec{dl} = \mu_o \boldsymbol{I}$.
- Applications:

Magnetic field due to straight infinitely long current carrying straight conductor. $B = \mu_0 \mathbf{I}/2\pi r$.
Magnetic field due to a straight solenoid carrying current $B = \mu_0 n \mathbf{I}$. n= no. of turns per unit length. $B = \mu_0 N \mathbf{I} / L$.
Magnetic field due to toroidal solenoid carrying current. $B = \mu_0 N \mathbf{I} / 2\pi r$. N= Total no. of turns.

- Force on a moving charge [Lorentz Force]: In magnetic field magnetic Lorentz force $\vec{F} = q(\vec{V} \, X \, \vec{B})$. The direction of Force is given by Fleming's left hand rule. In magnetic and electric field Lorentz force $\vec{F} = q[\vec{E} + (\vec{v} \, x \, \vec{B})]$.
- One Tesla is the intensity of magnetic field in which one coulomb of charge moving perpendicular to the field with one m/s experiences a force of one Newton.
- Motion of a charge in Perpendicular magnetic field $F = qvBSin\theta$. If $\theta = 90^o$ then $F = qvB$ (circular path). For parallel or antiparallel to magnetic field then $F = qvBSin0$ (or) $qvBSin180 = 0$(Straight-line path). If $0 < \theta < 90$, the path is helix. $v\,Cos\theta$ is responsible for linear motion, $v\,Sin\theta$ is responsible for circular motion. Hence trajectory is a helical path. When a charged particle enters in to the magnetic field with some angle θ to it, the radius of circular path followed by it is $r = mv\,sin\theta / qB$, and the pitch of the helical path is $2\pi mv\,cos\theta / qB$
- Cyclotron: The device which is used accelerate the charged particles based on the principle of Lorentz force is called Cyclotron.
- Principle: The charged particle accelerates in uniform electric field and follows circular path in uniform magnetic field.

- 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.
- Cyclotron frequency or magnetic resonance frequency $v=qB/2\pi m$, $T=2\pi m/Bq$; $\omega=Bq/m$
- Maximum velocity and maximum kinetic energy of charged particle $V_m=Bqr_m/m$
- $E_m=B^2q^2r_m^2/2m$.
- Force on a current carrying conductor in uniform $\vec{F} = (\overrightarrow{I\,l} \times \vec{B})$. l=length of conductor.
- Direction of force can be found out using Fleming's left hand rule.
- Force per unit length between parallel infinitely long current carrying straight conductors. $F/L = \mu_o I_1 I_2/2\pi d$. If currents are in same direction the wires will attract each other.If currents are in opposite directions they will repel each other.
- One Ampere: The electric current flowing through a conductor is said to be one ampere when it is separated by one meter from similar conductor carrying same amount of current in the same direction experiences a repulsive force of 2×10^{-7} N per meter length.
- Torque experienced by a current loop in a uniform B. τ = NIBA Sinθ. $\vec{\tau} = \vec{M} X \vec{B}$ Where M is the magnetic dipole moment =NIA
- Moving coil galvanometer: It is a sensitive instrument used for detecting small electric currents.
- Principle: A current carrying coil placed in a magnetic field experiences torque. $I \alpha \theta$ and $I = K\,\theta$ where K= NAB / C
- Current sensitivity, $\mathbf{I}_s = \theta / \mathbf{I}$=NBA/K
- Voltage sensitivity, Vs= θ /V=NBA/KR
- Changing N changes the Current sensitivity but Voltage Sensitivity does not change as R also changes in the same way and N/R remains constant.
- The amount of electric current per deflection in the galvanometer is called its figure of merit. G = I / α = k/NBA
- Conversion of galvanometer into ammeter: A small resistance S is connected in parallel to the galvanometer coil. $S=I_gG/(\mathbf{I} - \mathbf{I}_g)$; R_A=GS/(G+S)
- 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
- Magnetic dipole moment of a revolving electron M = $\frac{evr}{2}$. M=n(eh/4πm_e)
- The magnetic dipole moment of the revolving electron in its first orbit of the hydrogen atom is called Bohr Magneton. Bohr Maneton = eh/4πm_e = 9,27 x 10^{-24} Am^2.

- The ratio of orbital magnetic moment and the angular moment of revolving electron is called gyromagnetic ratio. $M/L = e/2m_e = 8.8 \times 10^{10}$ C/kg.
- Properties of bar magnet: Magnetic poles exist in pairs. Like poles repel and unlike poles attract.

It aligns in the direction of geographic north and south when suspended freely.
It attracts other magnets and magnet like materials.

- Properties of magnetic lines of force:

They emerge out of North Pole and directed towards South Pole.
They never cross each other.
They form closed loops.
They pass through conductors.
They contract lengthwise and expand sidewise.
Their relative density gives the intensity of magnetic field in that region.
They emerge out normal to the surface.

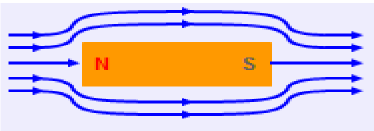
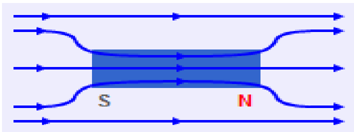
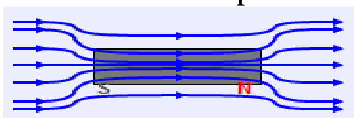
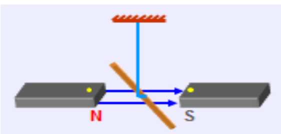
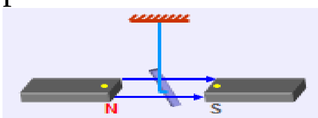
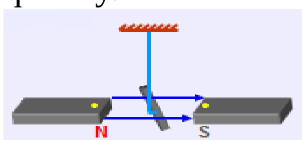
- Magnetic field due to a short bar magnet: At any point on its axial line: $B_{axial} = \frac{\mu_o}{4\pi}\frac{2m}{r^3}$. At any point on its equatorial line: $B_{eq} = \frac{\mu_o}{4\pi}\frac{m}{r^3}$.
- Torque on a bar magnet placed in uniform external magnetic field: $= mB\ sin\theta$; $\vec{\tau} = \vec{m}\ x\ \vec{B}$.
- Potential energy stored in bar magnet placed in uniform external magnetic field: $U = -\vec{m}.\vec{B} = -mB(cos\theta_2 - \cos\theta_1)$.
- Gauss's law in magnetism: $\varphi_B = \oint \vec{B}\,.\overrightarrow{dS} = 0$.
- Elements of earth's magnetic field: Magnetic declination (θ); Dip (δ); Horizontal component of earth's magnetic field (B_H). $B_H = B\cos\delta$; $B_V = B\sin\delta$.
- Magnetic flux density, $B_o = \mu_o / A$; SI unit wb / m^2.
- Magnetizing field intensity, $H = B_o / \mu_o$; SI unit A/m.
- Intensity of magnetization, I = m/V (magnetic dipole moment per unit volume); SI unit A/m.

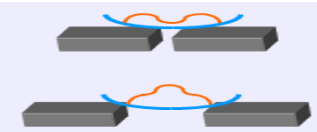
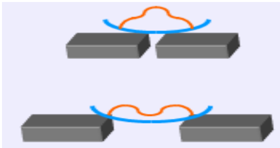
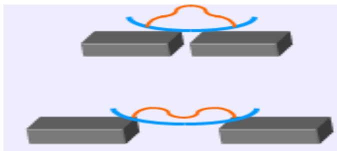
The relation among these three physical quantities is $B = \mu_o(H + I)$

- Magnetic permeability, $\mu = B/H$; SI unit wb/m/A
- Magnetic susceptibility, $\chi_m = \frac{I}{H}$; It is a dimensionless physical quantity.

Relation between relative permeability and magnetic susceptibility is $\mu_r = 1 + \chi_m$.

- Properties of magnetic substances

DIA	PARA	FERRO
1. Diamagnetic substances are those substances which are feebly repelled by a magnet. Eg. Antimony, Bismuth, Copper, Gold, Silver, Quartz, Mercury, Alcohol, water, Hydrogen, Air, Argon, etc.	Paramagnetic substances are those substances which are feebly attracted by a magnet. Eg.Aluminium, Chromium, Alkali and Alkaline earth metals, Platinum, Oxygen, etc.	Ferromagnetic substances are those substances which are strongly attracted by a magnet. Eg. Iron, Cobalt, Nickel, Gadolinium, Dysprosium, etc.
2. When placed in magnetic field, the lines of force tend to avoid the substance. 	The lines of force prefer to pass through the substance rather than air. 	The lines of force tend to crowd into the specimen. 
3. When placed in non-uniform magnetic field, it moves from stronger to weaker field (feeble repulsion).	When placed in non-uniform magnetic field, it moves from weaker to stronger field (feeble attraction).	When placed in non-uniform magnetic field, it moves from weaker to stronger field (strong attraction).
4. When a diamagnetic rod is freely suspended in a uniform magnetic field, it aligns itself in a direction perpendicular to the field. 	When a paramagnetic rod is freely suspended in a uniform magnetic field, it aligns itself in a direction parallel to the field. 	When a paramagnetic rod is freely suspended in a uniform magnetic field, it aligns itself in a direction parallel to the field very quickly. 

5. If diamagnetic liquid taken in a watch glass is placed in uniform magnetic field, it collects away from the centre when the magnetic poles are closer and collects at the centre when the magnetic poles are farther. 	If paramagnetic liquid taken in a watch glass is placed in uniform magnetic field, it collects at the centre when the magnetic poles are closer and collects away from the centre when the magnetic poles are farther. 	If ferromagnetic liquid taken in a watch glass is placed in uniform magnetic field, it collects at the centre when the magnetic poles are closer and collects away from the centre when the magnetic poles are farther. 
6. Induced Dipole Moment (M) is a small – ve value.	Induced Dipole Moment (M) is a small + ve value.	Induced Dipole Moment (M) is a large + ve value.
7. Intensity of Magnetisation (I) has a small – ve value.	Intensity of Magnetisation (I) has a small + ve value.	Intensity of Magnetisation (I) has a large + ve value.
8. Intensity of Magnetisation (I) has a small – ve value.	Intensity of Magnetisation (I) has a small + ve value.	Intensity of Magnetisation (I) has a large + ve value.
9. Magnetic permeability μ is always less than unity.	Magnetic permeability μ is more than unity.	Magnetic permeability μ is large i.e. much more than unity.
10. Magnetic susceptibility χ_m has a small – ve value.	Magnetic susceptibility χ_m has a small + ve value.	Magnetic susceptibility χ_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. $\chi_m = C/T$ Where C is curie's constant.	They obey Curie's Law. At a certain temperature called Curie Point, they lose ferromagnetic properties and behave like paramagnetic substances.

- Hysteresis: The phenomenon of lagging of magnetic flux density behind the magnetizing field intensity of a ferromagnetic substance is called Hysteresis.
- The magnetic flux density remained in the ferromagnetic substance even after removing the magnetizing field intensity is called Retentivity.
- The magnetizing field intensity required to reduce the residual magnetism in ferromagnetic substance to zero is called coercivity.

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.

Ans; 0.06N2

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

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

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

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

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

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

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

8 A charged particle of mass 'm' charge 'q' moving at a uniform velocity 'v'

enters a uniform magnetic field ‘B’ normal to the field direction. Deduce an expression for Kinetic Energy of the particle. Why does the Kinetic Energy of the charged particle not change when moving through the magnetic field? 3

9 An electron is revolving around the nucleus of an atom in an orbit of radius 0.53 Å. Calculate the equivalent magnetic moment, if the frequency of revolution of the electron is 6.8×10^{9} MHz.
Ans: $p_m = 9.6 \times 10^{-24}$ A m^2 3

BIOT-SAVART LAW AND ITS APPLICATIONS

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

2 A wire placed along north south direction carries a current of 5 A from South to North. Find the magnetic field due to a 1 cm piece of wire at a point 200 cm North East from the piece. 2
Ans: 8.8×10^{-10} T, acting vertically downwards.

3 How will the magnetic filed intensity at the centre of a circular coil carrying current change if the current through the coil is doubled and the radius of the coil is halved. 2
Ans: $B = \mu_0 n \times 2I / 2 \times (R/2) = 4B$

4 A circular coil of 500 turns has a radius of 2 m, and carries a current of 2 A. What is the magnetic field at a point on the axis of the coil at a distance equal to radius of the coil from the center? 2
Ans: $B = 1.11 \times 10^{-4}$ T

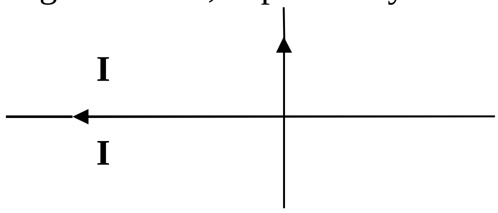
5 The strength of magnetic induction at the center of a current carrying circular coil is B_1 and at a point on its axis at a distance equal to its radius from the center is B_2. Find B_1/B_2. 2
Ans: $2\sqrt{2}$

6 A current is flowing in a circular coil of radius ‘r’ and magnetic field at its center is B_0. At what distance from the center on the axis of the coil, the magnetic field will be $B_0/8$? 2
Ans: $x = \sqrt{3}r$

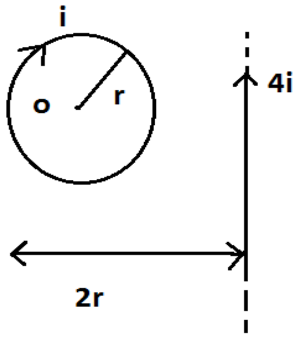
7 A straight wire of length$'\frac{\pi}{2}'m$, is bent into a circular shape. if the wire were to carry a current of 5 A, calculate the magnetic field due to it, before bending, at a point 0.01 times the radius of the circle formed from it. Also calculate the magnetic field at the center of the circular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



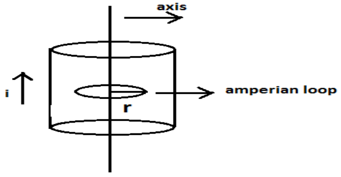
Ans: $(\mu_0 I / 2r) = (\mu_o i/\pi r)$ 3

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
Ans; (a) $\mu_0\mu_r Ir/2\pi R^2$ (b) $\mu_0 2I/ 4\pi r2$

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.

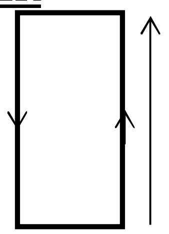
3 Find the value of magnetic field inside a hollow straight current carrying conductor at a distance r from axis of the loop. 2



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 $=7.8175 \times 10^{-4}$ 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.

Ans: 0.49Nm2

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.

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.
Ans: $B_1 = 1.25 \times 10^{-3}$ T , $B_2 = 0.625 \times 10^{-3}$ 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.
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?
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?

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

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.
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 ($B_H = B \cos \delta$, $B_H = \mu_0 I/ 2\pi r$)

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?
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?
Ans: 75^0 west of north.

IMPORTANT TERMS IN MAGNETISM

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

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

MAGNETIC PROPERTIES OF MATERIALS

1 The susceptibility of magnesium at 300K is 1.2 x 10^5. At what temperature will the susceptibility be equal to 1.44 x 10^{-5} .
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?

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

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

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

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.

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

4. ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENTSGIST

- The phenomenon of production of induced emf in a conductor when electric flux linked with that changes is called electromagnetic induction.
- Magnetic flux through a surface of area A placed in a uniform magnetic field B is defined as $\Phi_B = \vec{B}.\vec{A}$ = BA Cosθ where θ is the angle between B and A.
- Magnetic flux is a scalar quantity and its SI unit is weber (Wb).
- Faraday's laws of induction:

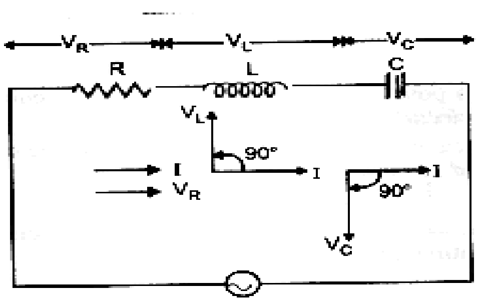
First Law: When magnetic flux linked with the conductor changes, induced emf produces across it.

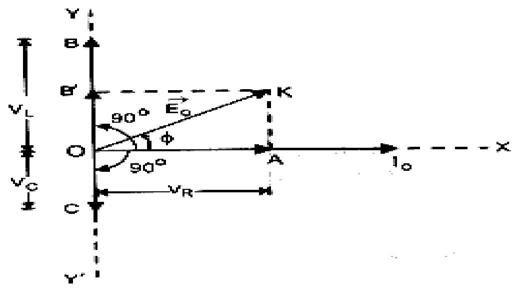
Second Law: The magnitude of the induced e.m.f in a circuit is equal to the rate of change of magnitude flux linked with that circuit.$\varepsilon = \frac{d\emptyset_B}{dt}$

- Lenz law:The direction of induced current or the polarity of the induced e.m.f is in such a way that it opposes the cause that produces it. (The negative sign in Faraday's law indicates this fact.)$\varepsilon = -\frac{d\emptyset_B}{dt}$. Lenz law obeys the principle of energy conservation.
- The induced current in a closed loop can be produced by changing the (i) magnitude of B (ii) area A of the loop (iii) its orientation in magnetic field.
- The direction of induced current is obtained from Fleming's right hand rule.
- 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. It produces across the ends of the rod. ε = Blv.If 'R' is the resistance of the metal rod, the induced current is given by I=Blv/R, the force acting on the conductor in the presence of magnetic field (due to drift of charge) is given by $F = B^2l^2v / R$. The power required to move the conductor with a constant speed is given by $P = B^2l^2v^2/R$.
- The induced currents produced on the surface of a thick conductor when magnetic flux linked with that changes are called eddy currents.
- The phenomenon of production of induced emf in a coil itself when electric current passing through that changes is called self induction. Self Inductance is the ratio of the flux linkage to current.$L = \frac{\varphi}{I}$.
- When a current in a coil changes it induces a back e.m.f in the same coil. The self inducede.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).
- The inductance is said to be one Henry when an emf of one volt induces in a coil for unit rate of change of electric current through it.

- The 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. ($M_{12} = M_{21}$).
- The self-inductance of a long solenoid is given by $L = \mu_0 n^2 Al$ where A is the area of cross-section of the solenoid, l is its length and n is the number of turns per unit length.
- 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.
- Energy stored in an inductor in the form of magnetic field is $U_B = \frac{1}{2}Li_{max}^2$ and Magnetic energy density $U_B = \frac{B^2}{2\mu_0}$
- The electric current whose magnitude changes continuously and direction changes periodically is called alternating current (AC). $I = I_o \text{Sin}\, \omega t$.
- The root mean square value of a.c. may be defined as that value of steady current which would generate the same amount of heat in a given resistance in a given time as is done by the a.c. when passed through the same resistance during the same time. $I_{rms} = I_0/\sqrt{2} = 0.707i_0$. Similarly, $v_{rms} = v_0/\sqrt{2} = 0.707v_0$.
- The rotating vectors which represent the varying quantities are called phasors. The diagram in which the AC voltage and AC currents are represented as phasors is called phasor diagram.
- The opposition offered by resistor is called resistance (R). The non-resistive opposition offered by a device is called reactance (X). The combination of reactance and resistance is called impedance (Z).
- An alternating voltage $\varepsilon = \varepsilon_0 \text{Sin}\omega t$, 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)
- For an AC emf $\varepsilon = \varepsilon_m \text{Sin}\ \omega t$ applied to a resistor, current and voltage are in phase.
- In case of an a.c. circuit having pure inductance current lags behind e.m.f by a phase angle 90°. $\varepsilon = \varepsilon_m \text{Sin}\ \omega t$ and $i = i_m \text{Sin}\ (\omega t - \pi/2)$. $I_m = \varepsilon_m/X_L$; $X_L = \omega L$ is called inductive reactance.
- In case of an a.c. circuit having pure capacitance, current leads e.m.f by a phase angle of 90°. $\varepsilon = \varepsilon_m \text{Sin}\omega t$ and $I = I_m \text{Sin}(\omega t + \pi/2)$ where $I_m = \varepsilon_m/X_C$ and $X_C = 1/\omega C$ is called capacitive reactance.
- In case of an a.c. circuit having R, L and C, the total or effective resistance of the circuit is called impedance (Z).

- $Z = \varepsilon_m / I_m = \sqrt{R^2 + (X_C - X_L)^2}$. $\tan\Phi = \dfrac{X_c - X_L}{R}$, where φ is the phase difference between current and voltage. $\varepsilon = \varepsilon_m \sin\omega t$, $I = I_m \sin(\omega t + \Phi)$.





- 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 $\Phi = \pi/2$; $P = 0$.
- The electric current in an AC circuit is said to be wattless current when average power dissipated or consumed is zero.
- 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 $\vartheta_R = \frac{1}{2\pi\sqrt{LC}}$.
- The device which converts mechanical energy in to AC electrical energy by virtue of electromagnetic induction is called AC Generator.
- 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 $I = \varepsilon/R = \varepsilon_0 \sin\omega t/R = I_0 \sin\omega t$
- The device which converts an AC voltage of one value to another is called Transformer. For an ideal 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.
- Losses in transformer: Copper losses; Iron losses, Flux losses; Hysteresis losses; Humming losses.
- When a charged capacitor is allowed to discharge through an inductor, electrical oscillations of constant amplitude and frequency are produced, which is called LC oscillations. The charge on capacitor q satisfies the equation of SHM $\frac{d^2q}{dt^2} + \frac{1}{LC} q = 0$.

(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	$E=E_0 \sin \omega t$	$I = I_0 \sin (\omega t \pm \theta)$	$Z = \sqrt{R^2 + (X_L - X_C)^2}$	$\tan \phi = \frac{X_C - X_L}{R}$	$E_v I_v \cos \phi$	$\cos \phi = \frac{R}{\sqrt{R^2+(X_L-X_C)^2}}$

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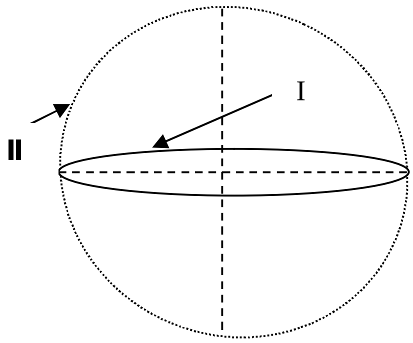
QUESTIONS
MAGNETIC FLUX, INDUCED E.M.F.

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



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

2 A closed loop of wire is being moved with constant velocity without changing its orientation inside a uniform magnetic field. Will this induce a current in the loop? 1

[Ans: No there is no change in Φ_B]

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

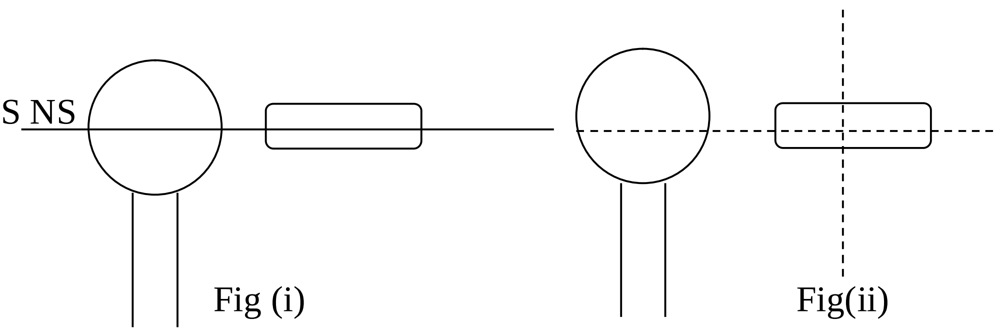


Fig (i) Fig(ii)

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 1

fall freely. Will an e.m.f be induced in the wire?
(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

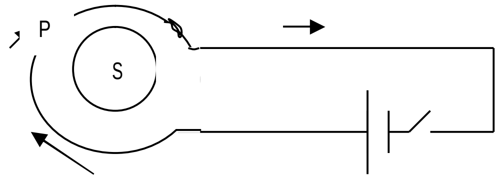
10 The magnetic flux linked with a coil passing perpendicular to the plane of the coil changes with time $\Phi = 4t^2 + 2t + 3$, where "t" is the time in seconds. What is magnitude of e.m.f induced at t = 1 second? 3
Ans: ($e = d\Phi/dt = \frac{d}{dt}\left(4t^2 + 2t + 3\right)$, $e = 8t + 2$ If t = 1s e= 10V)

11 A wheel fitted with spokes of radius 'r' is rotating at a frequency of n revolutions per second in a plane perpendicular to magnetic field B Tesla. What is the e.m.f induced between the axle and rim of the wheel [2] 3
$\Phi = BA$

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

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

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



Ans: (i) anticlockwise (ii) clockwise

13 A conducting circular loop is placed in a uniform magnetic field B = 0.020T with its plane perpendicular to the field. Somehow, the radius of the loop starts shrinking at a constant rate of 1mm/s. Find the induced current in the loop at an instant when the radius is 2cm. 2

Ans. ($\Phi = \Pi r^2 B$ d $\Phi/dt = 2\Pi rB$ dr/dt e= 25µV

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

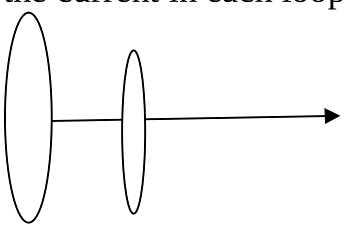
Ans. (I initial=2A I final= 0 ϵ=-Ldi/dt = 20000V)

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

Ans. (0.04 V)

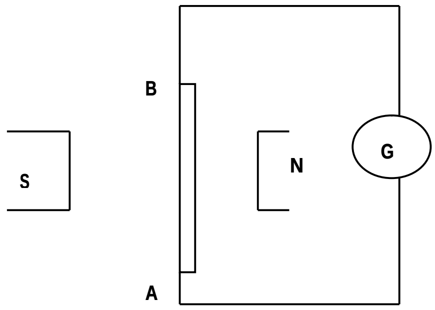
16 A conducting rod of length l with one end pivoted is rotated with a uniform angular speed ω in a Vertical plane normal to uniform magnetic field B. Deduce an expression for e.m.f induced in this rod. 2

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



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

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

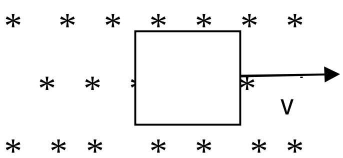


19 A fan blade of length 0.5 m rotates perpendicular to a magnetic field of $5x10^{-5}$ T. If the e.m.f induced between the centre and the end of the blade is 10^{-2} V .Find the rate of rotation. 3

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

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

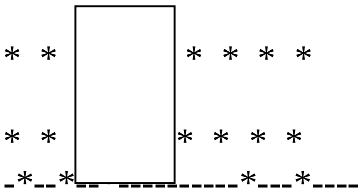
P Q R



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

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

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



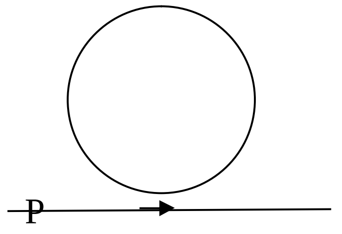
(mg = B^2l^2v/r ; v=mgr/ B^2l^2)

23 A loop of wire is placed in a magnetic field B =0.2i .Find the flux through the loop if area vector is A = (3i + 6j+2k)m^2. 3

Ans:0.6wb

24 A conducting loop is held above a current carrying wire PQ as shown in fig. What will be the direction of the induced current in the loop if the current in the wire PQ is constantly increased? 3

Ans:clockwise



INDUCTANCE

1 Two conducting circular loops of radii R_1 and R_2 are placed in the same plane with their centres coinciding. Find the mutual inductance between them assuming $R_2 << R_1$. 2

($M=\mu_0 \pi R_2^2 /2R_1$)

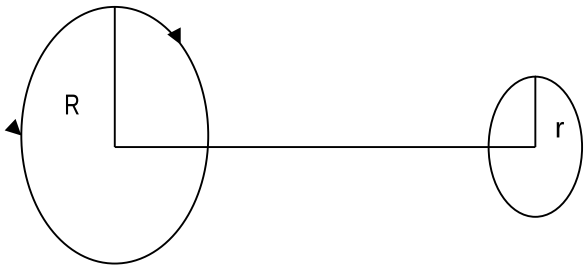
2 Prove that the total inductance of two coils connected in parallel is 2

$$\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2}$$

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

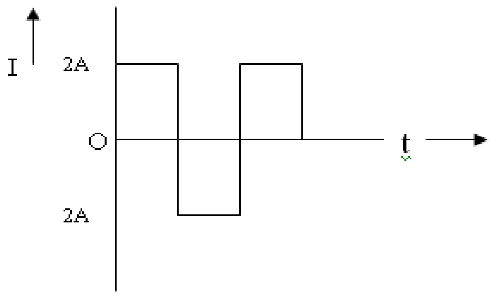
4 A coil of wire of certain radius has 600 turns and inductance of 108mH. What will be the inductance of another similar coil with 500 turns? (75mH) 2

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



ALTERNATING CURRENT -RMS CURRENT AND VOLTAGE

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



Ans:- √2A

2 The instantaneous value of e.m.f is given by ε= 300sin 314t. What is the peak value and 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

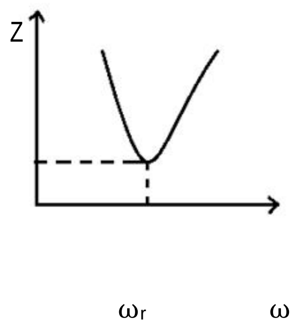
Ans: $\sqrt{\frac{(i_1^2+i_1^2)}{2}}$

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

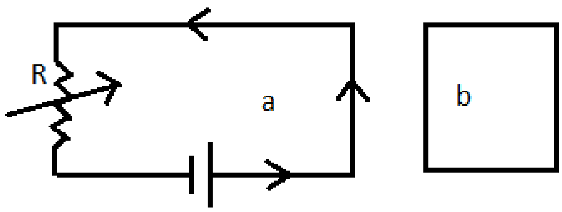
10 If a constant current of 2.8A exists in a resistor, what is the rms value of current? Why? (2) 2

Ans: 2.8A

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



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



Ans: Clockwise

AC CIRCUITS

1 What is meant by wattless current? 1

2 Define: Q factor in LCR series circuit 1

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

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

Ans: a) R remains unaffected

b) $X_L=2\pi fL$, so doubled

c) $X_C=1/2\pi fC$, so halved

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

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

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

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 resistor 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

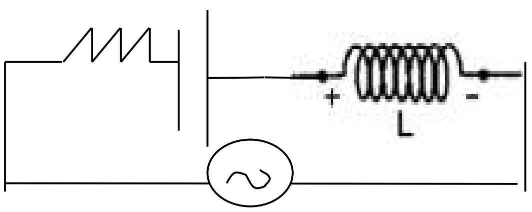
16 Define and derive the root mean square value of a.c voltage 3

<u>RESONANCE in LCR Circuits</u>

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/ωC=ωL ; C=1/ω^2L=63nF.

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



Hint: X_L=2πfL X_C=1/2πfC

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) $\upsilon = \upsilon_r$ (ii) $\upsilon < \upsilon_r$ (iii) $\upsilon > \upsilon_r$, where υ_r resonant frequency? 1

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

Ans: In series LCR circuit voltage across capacitor and inductor are in opposite phase, so net voltage across the combination of L and C becomes 60-30=30V. Total voltage across R and L = 50V

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

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

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

Ans: Q=45,ω_0=111rad/s

11 An A.C source of voltage V= V_mSinωt is connected one-by-one to three circuit elements 5

X, Y and Z. It is observed that the current flowing in them

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.

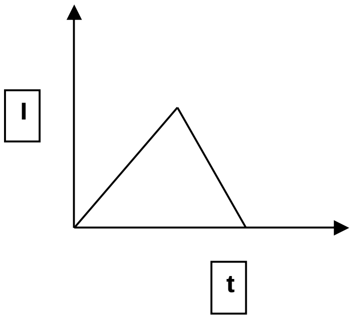
Identify the three circuit elements.

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: emf has constant positive value in the first part and a constant negative value in the second part)

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

A transformer has an efficiency of 80% It works at 4kW and 100V. If the secondary voltage is 240V 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

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

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. 2

(1.1 Tesla)

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

(i) What is the maximum current drawn from the generator?

(ii)What is the flux through the coil when current is zero?

(iii) What is the flux when current is maximum?

(4.5A, 375Wb, zero)

ELECTRO MAGNETIC WAVESGIST

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

Gauss's Law in Electrostatics: $\oint \vec{E}.\vec{dS}=\frac{Q}{\epsilon_0}$

Gauss's Law in Magnetism: $\oint \vec{B}.\vec{dS}=0$

Faraday's -Lenz law of electromagnetic induction: $\oint \vec{E}\,.\vec{dl}=-\frac{d}{dt}\oint \vec{B}\,.\vec{dS}$

Ampere's – Maxwell law: $\oint \vec{B}\,.\vec{dl} = \mu_0 I + \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$

- Electromagnetic Wave:-The variation of electric and magnetic fields, perpendicular to each other, producing electromagnetic disturbance in space at right angles to each other, which have properties of waves and propagate through free space without any materialistic medium is called electromagnetic wave.
- Properties of electromagnetic waves:

E M Waves are transverse in nature.
They are produced by oscillating or accelerating charged particles.
They do not require any medium for their propagation.
They obey principle of superposition.
They show polarization effect.
Electric field is only responsible for optical effects of EM waves.
The amplitude of electric & magnetic fields are related by $\frac{E}{B} = c$
In free space they travel with the speed $c = \frac{1}{\sqrt{\epsilon_o \mu_o}}$.
The energy of E M Wave is equally divided between electric and magnetic field vectors.
EM waves also carry energy, momentum and information.

- Electromagnetic Spectrum: The orderly arrangement of electro-magnetic radiation according to its frequency or wavelength is called electromagnetic spectrum.

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
Micro-wave	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.
Ultra-violet	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.

QUESTIONS

1.What is the highest frequency for which antennas can be made (approximately)

10^{12} to 10^{13} Hz.

2. What is the condition of the electrons in the transmitting antenna when maximum magnetic field is being transmitted?

A maximum current is flowing, so the electrons have maximum speed up and down the antenna. The electric current produces the magnetic field.

3. How can the electric portion of the electro-magnetic wave be detected?

It can be detected by an antenna similar to the transmitting antenna except that a detector of electric current replaces the voltage source.

4. How can the magnetic field portion of an electro-magnetic wave be detected?

The magnetic wave is best detected by placing a loop of wire (with its ends hooked to a current detector) in the path of the wave. The changing magnetic field causes a current in the loop.

5.The small ozone layer on the top of the atmosphere is crucial for human survival. Why?

The ozone in the atmosphere is confined to the ozone layer, some 50-80 km above the ground. The ozone layer blocks the passage of the ultra-violet radiations; x-rays and y-rays from the solar and other extra-terrestrial sources and effectively protects us from the dangerous and harmful portions of solar radiations as they cause genetic damages to living cells. Practically all radiations of wave length less than 3×10^{-7}m are absorbed by the ozone layer. This explains why ozone layer on the top of the atmosphere is crucial for human survival.

6.How does "Green House Effect" affect the temperature of the earth's surface ?

Green house effect serves to keep the earth's surface warm at night.

7.How do we make television broadcasts for larger coverage and for long distance?

By using (i) tall antennas which is familiar landmark in many cities and (ii) using artificial satellites —called geostationary satellites. Since television signals are of high frequency and are not reflected by ionosphere so we use satellites to get them reflected & transmission of TV signals can be used for larger coverage as well as for long distance.

8. Scientists put x-ray astronomical telescope on the artificial satellite orbiting above the earth's atmosphere whereas they build optical and radio-telescopes on the surface of the earth. Why ?

X-rays have very high frequency and much smaller wavelength. These rays get absorbed by the earth's atmosphere. On the other hand, optical (visible) radiations and radio-waves can pass through the atmosphere. That is why optical and radio telescopes can be installed on the earth's surface.

9. For an electromagnetic wave, write the relationship between amplitude of electric and magnetic fields in free space.

[Hints If E_0 is the amplitude of an electric field and B_0 is the amplitude of the associated magnetic field in free space then $c = \frac{E_0}{B_0}$ where c is the *speed of light* in free space *i.e.* 3×10^8 m/s.

10. The charging current for a capacitor is 0.25 A. What is the displacement current across its plates?

Hints: Displacement current = Charging current = 0.25 A]

11. What is a ground wave? How does it differ from a sky wave?

Ans. A signal emitted by an antenna from a certain point can be received at another point of the surface of the earth in two ways. The wave which travels directly following the surface of the earth is called ground *nave*. The wave that can reach the same point after being reflected from the ionosphere is called *sky wave*.

12. Why short wave communication over long distances is not possible via ground waves?

|Hints: Because the wave gets attenuated.]

13. Are conduction and displacement currents the same?

[Hint: No; they are different but they are equal .

14. It is necessary to use satellites for long distance TV transmission. Why?

It is so because television signals are not properly reflected by the ionosphere. Therefore, for reflection of signals satellites are needed as reflection is effected by satellites.

15. Optical and radio telescopes are built on ground but X-ray astronomy is possible only from satellites orbiting the earth. Why?

Atmosphere absorbs X-rays, while visible and radiowaves can penetrate it. That is why optical and radio telescopes can work on earth's surface but X-ray astronomical telescopes must be used on satellites orbiting the earth.

16. If the earth did not have an atmosphere, would its average surface temperature be higher or lower than what it is now?

Ans. The temperature of the earth would be lower because the green house effect of the atmosphere would be absent.

.

17. What is the equation for the speed of electromagnetic waves in free space?

$$C = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$

18. The wavelength of electro magnetic radiation is doubled. What will happen to the energy of the photon?

The energy will be halved because frequency will be halved.

19. Name the part of electromagnetic spectrum to which waves of wavelength (i) 1A° and (ii) 10^{-2} m belong. Using the relation λT = (0.29 cm) K, obtain the characteristic kelvin temperature corresponding to these two wavelengths.

(i) X-rays, (ii) Microwaves

Again, (i) $T = \frac{0.29\, cm}{1 \times 10^{-10}\, cm} = 29 \times 10^{-8}\ K$ (ii) $T = \frac{0.29\, cm}{1\, cm} = 0.29\ K$

20. Give a simple argument to suggest that an accelerated charge must emit electromagnetic radiation

Ans. When charge moves with constant velocity, the magnetic field does not change with time. So, it cannot produce an electric field. When charge is accelerated, both electric and magnetic fields change with time and space, one becoming a source of another. This gives rises to electromagnetic wave.

21. Show that the average energy density of the E field equals the average energy density of the B field.

Ans. Energy density in E field, $u_E = \frac{1}{2}\varepsilon_0 E^2$

Energy density in B field,------------- $u_B = \frac{1}{2\mu_0} B^2$

Using E = cB and c = $\frac{1}{\sqrt{\mu_0 \varepsilon_0}}$, uE = uB.

22. On what factors does its velocity in vacuum depend?

Ans. Electromagnetic waves consist of sinusoidal variation of electric and magnetic field vectors. The field vectors vibrate with the same frequency and are in the same phase. The field vectors and the direction of propagation are all mutually perpendicular. The velocity of electromagnetic waves in vacuum depends upon absolute permeability μ_0 and absolute permittivity ε_0.Note that c = $\frac{1}{\sqrt{\mu_0 \varepsilon_0}}$

23. What is the name associated with the following equations?

(i) $\oint \vec{E}.d\vec{S} = \frac{q}{\varepsilon_0}$ (ii) $\oint \vec{B}.d\vec{S} = 0$

(iii) $\oint \vec{E}.d\vec{l} = -\frac{d}{dt}\int \vec{B}.d\vec{S}$ (ii) $\oint \vec{B}.d\vec{S} = \mu_0 \varepsilon_0 \frac{d}{dt}\int \vec{E}.d\vec{S} + \mu_0 I$

(i) Gauss's law (ii) No particular name

(iii) Faraday's law (iv) Ampere's law.

24. Electromagnetic waves with wavelength

(i) $\lambda_1$are used to treat muscular strain

(ii) λ_2 are used by a FM radio station for broadcasting

(iii) λ_3 are used to detect fracture in bones

(iv) λ_4 are absorbed by the ozone layer of the atmosphere.

Identify and name the part of the electromagnetic spectrum to which these radiations belong. Arrange these wavelengths in decreasing order of magnitude.

Ans. (i) λ_1 -»infrared (ii) λ_2 -» radiowaves

(iii) λ_3 —> X-rays (in) λ_4 —> ultra-violet rays $\lambda_2 > \lambda_1 > \lambda_4 > \lambda_3$.

25. If you find closed loops of B in a region in space, does it necessarily mean that actual charges are flowing across the area bounded by the loops?

Ans. Not necessarily. A displacement current such as that between the plates of a capacitor that is being charged can also produce loops of B •

26. A closed loop of B is produced by a changing electric field. Does it necessarily mean that E and $\frac{dE}{dt}$ are non-zero at all points on the loop and in the area enclosed by the loop?

Ans. Not necessarily. All that is needed is that the total electric flux through the area enclosed by the loop should vary in time. The flux change may arise from any portion of the area. Elsewhere E or $\frac{dE}{dt}$ may be zero. In particular, there need be no electric field at the points which make the loop.

27. Why is it that induced electric fields due to changing magnetic flux are more readily observable than the induced magnetic fields due to changing electric fields?

Ans. The magnitude of the magnetic field due to displacement current is too small to be easily observable. This effect can of course be increased by increasing the displacement current. [In an AC circuit, this can be done by increasing ω.]

On the other hand, the effect of induced electric field due to changing magnetic flux can be increased simply by taking more and more number of turns in the coil. The induced emfs in different turns of the same coil add up in series.

28. A variable-frequency AC source is connected to a capacitor. Will the displacement current increase or decrease with increase in frequency?

Ans. Increase in frequency causes decrease in impedance of the capacitor and consequent increase in the current which equals displacement current between the plates.

29. Some scientists have predicted that a global nuclear war on the earth would be followed by a severe 'nuclear winter' with a devastating effect on life on earth. What might be the basis of this prediction?

Ans. The clouds produced by a global nuclear war would perhaps cover substantial parts of the sky preventing solar light from reaching many parts of the globe. This would cause a 'winter'.

30. What is the contribution of the Greenhouse effect towards the surface temperature of the earth?

Ans. The infrared radiation emitted by the earth's surface keeps the earth warm. In the absence of this effect, the surface temperature of earth would be lower.

31. Why the small ozone layer on top of the stratosphere is crucial for human survival?

Ans. The small ozone layer on the top of the stratosphere absorbs ultraviolet radiations, y-rays etc. from the sun. It also absorbs cosmic radiations. So, these radiations, which can cause genetic damage to the living cells, are prevented from reaching the earth. Thus, the small ozone layer on top of the stratosphere is crucial for human survival.

32. A plane electromagnetic wave travels in vacuum along z-direction. What can you say about the directions of its electric and magnetic field vectors? If the frequency of the wave is 30 MHz, what is the wavelength?

Ans. E and B lie in the x-y plane and are mutually perpendicular. Wavelength,

$$\lambda = \frac{3x10^8}{30\times10^6} m = 10\ m$$

33. Given below are some famous numbers associated with electromagnetic radiation in different contexts in physics. State the part of the e m spectrum to which each belongs.

(i) 21 cm (wavelength emitted by atomic hydrogen in interstellar space).

(ii) 1057 MHz [frequency of radiation arising from two close energy levels in hydrogen; known as Lamb shift].

(Hi) 2.7 K temperature associated with the isotropic radiation filling all space-thought to be a relic of the 'big-bang' origin of the universe.

(iv) 5890 A - 5896 A [double lines of sodium].

(v) 14.4 keV [energy of a particular transition in 57Fe nucleus associated with a famous high resolution spectroscopic method (Mossbauer spectroscopy).

Ans. (i) Radio (short wavelength end) (ii) Radio (short wavelength end) (Hi) Microwave (iv) Visible (Yellow) (v) X-rays (or soft y-ray) region.

34. Electromagnetic waves in a cavity with conducting walls can exist only in certain modes i.e., they cannot exist, for example, with any arbitrary wavelength. Suggest a simple reason why this should be so.

Ans. The waves must satisfy a boundary condition. The electric field should be zero on the walls of the conductor. This restricts the possible modes. [It is something like the restricted

6. OPTICSRAY OPTICSGIST

- Laws of reflection:

1. The incident ray, normal and reflected ray all lie in the same plane.
2. The angle of incidence is always equal to angle of reflection.

- New Cartesian sign convention for spherical mirrors:

1. All the distance measurements are done from pole of the mirror and height measurements are from the principal axis.
2. The distances measured in the direction of incident ray are positive and in opposite direction of incident ray are negative.
3. The heights measured upwards from principal axis are positive and downwards negative.

- The relation between focal length and radius of curvature of spherical mirror is f = R/2
- 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.
- Linear magnification is ratio of the size of the image to the size of the object.Magnification $m=-\frac{v}{u}=\frac{f-v}{f}=\frac{f}{f-u}$. If m >1 then the image is magnified. If m<1 then the image is diminished. If m=1 then the image is of the same size of the object. If m is positive then the image is virtual and erect. If m is negative then the image is real and inverted.
- The phenomenon of bending of light at the interface of two media when it enters from one medium to another is called refraction of light.
- Laws of Refraction:

1. The incident ray, normal and refracted ray all lie in the same plane.
2. The ratio of sine of angle of incidence and sine of angle of refraction is constant for a given pair of media.

- Snell's law of refraction: The ratio of sine of angle of incidence and sine of angle of refraction is the refractive index of refracting medium with respect to the incident medium. $\frac{Sin i}{\sin r}=\frac{n_2}{n_1}$
- The ratio of speed of light in free space to that in medium is called absolute refractive index of that medium. $n=\frac{c}{v}$
- If the absolute refractive index medium 1 is greater than that of medium 2 then medium 1 is said to be optically denser medium and medium 2 is said to be optically rarer medium.
- The ratio of absolute refractive index of one medium to that of another is

called relative refractive index of both the media.

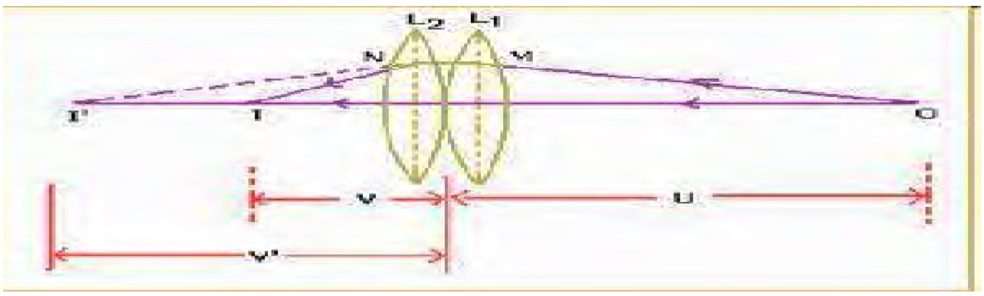
- Principle of reversibility: The relative refractive index of medium 2 w.r.t. medium 1 is reciprocal to the relative refractive index of medium 1 w.r.t. medium 2.
- An object under water (any medium) appears to be raised due to refraction when observed inclined

$n = \frac{Real\ depth}{apparent\ depth}$ and Shift in the position (apparent) of object is X = t { 1 – 1/n) where t is the actual depth of the medium.

- The Phenomenon of reflection of light completely in to the denser medium without refraction in to rarer medium is called Total Internal Reflection.
- Conditions for TIR:

1. The light must propagate from optically denser medium to optically rarer medium.
2. The angle of incidence in the denser medium must be greater than critical angle of incidence for the given pair of media.

- When a ray of light travels from denser to rarer medium and if the angle of incidence is greater than critical angle, the ray of light is reflected back to the denser medium. This phenomenon is called Total internal reflection. $SinC = \frac{n_R}{n_D}$
- Applications: Brilliance of diamond, totally reflecting prisms, Mirage, Looming, Optical Fibre.
- Refraction through spherical surfaces: When light falls on a convex refracting surface, it bends and the relation between U, V and R is given by $\frac{n_2}{V} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$.



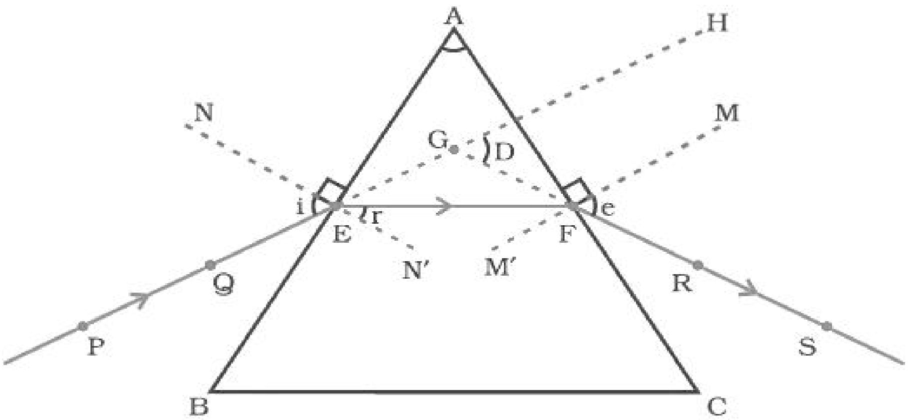
- Lens maker's formula or thin lens formula is given by $\frac{1}{f} = \left(\frac{n_2 - n_1}{n_1}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$.
- For Convex Lens R_1 +ve ;R_2 –ve Concave lens R_1-ve; R_2 +ve.
- When two lenses are kept in contact the equivalent focal length is given by

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

- $\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$ & $P = P_1 + P_2$
- Combination of lenses help to

1) Increase the magnification of the image
2) Increase the sharpness of the final image by reducing the defects of images formed by a singe lens.
3) Make the image erect w.r.t the object
4) Increase the field of view

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



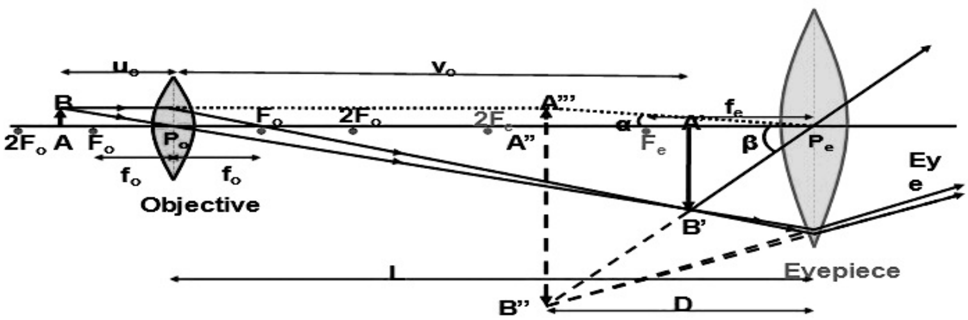
PE – Incident ray
EF – Refracted ray
FS – Emergent ray
∠A – Angle of the prism
∠i – Angle of incidence
∠r – Angle of refraction
∠e – Angle of emergence
∠D – Angle of deviation

- When light passes through a glass prism it undergoes refraction. The expression for refractive index is $n = \frac{Sin\left(\frac{A+D_m}{2}\right)}{Sin\left(\frac{A}{2}\right)}$. As the angle of incidence increases, the angle of deviation decreases, reaches a minimum value and then increases. This minimum value is called angle of minimum deviation "D_m".
- The phenomenon of splitting up of polychromatic light in to its constituent colours is called Dispersion of light.
- Cause of dispersion: According to Cauchy's *formula*, the refractive index (n) of a material depends upon wavelength (λ) and is given by:
- $\mu = a + b/\lambda^2 + c/\lambda^4$, where a, b, c are constants.
- 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.

1. Sky is blue.
2. Sun is reddish at the time of sunrise and sunset
3. Infra-red photography used in foggy days.
4. Orange colour of black Box
5. Yellow light used in vehicles on foggy days.
6. Red light used in signals.

COMPOUND MICROSCOPE

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.

Angular Magnification or Magnifying Power (M):

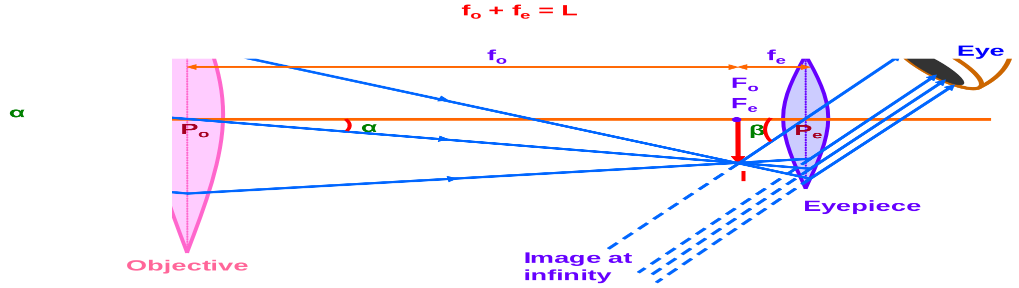
$M = M_e \times M_o$

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

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

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

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



Focal length of the objective is much greater than that of the eyepiece.

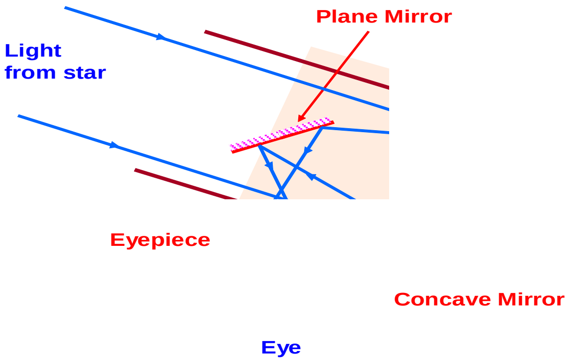
Aperture of the objective is also large to allow more light to pass through it.

Angular magnification or Magnifying power of a telescope in normal adjustment

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

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

Newtonian Telescope: (Reflecting Type)

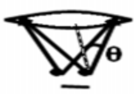


Magnifying Power:

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

Cassegrain telescope refer from NCERT / refer Page no 83

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



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

Resolving Power of a Telescope:

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

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

WAVE OPTICS

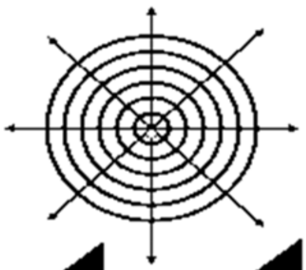
Wavefront:

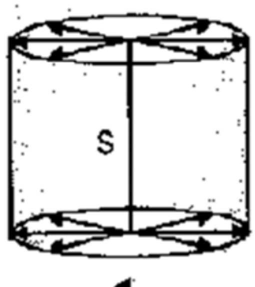
A wavelet is the point of disturbance due to propagation of light.

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

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

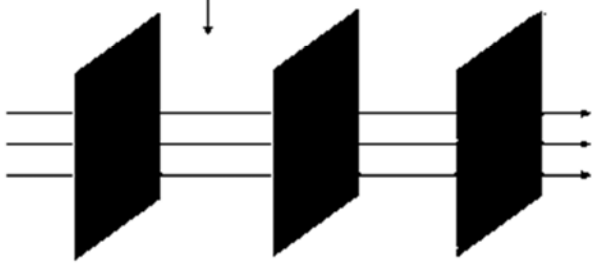
Spherical Wavefront from a



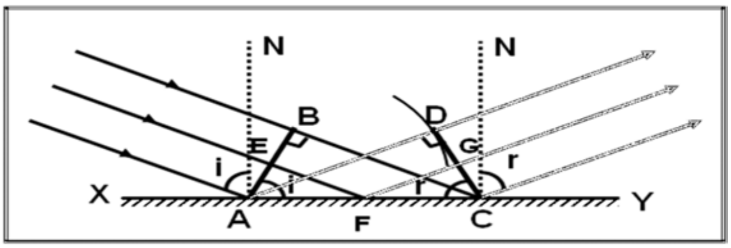


Cylindrical Wavefront from a linear source

Plane Wave front



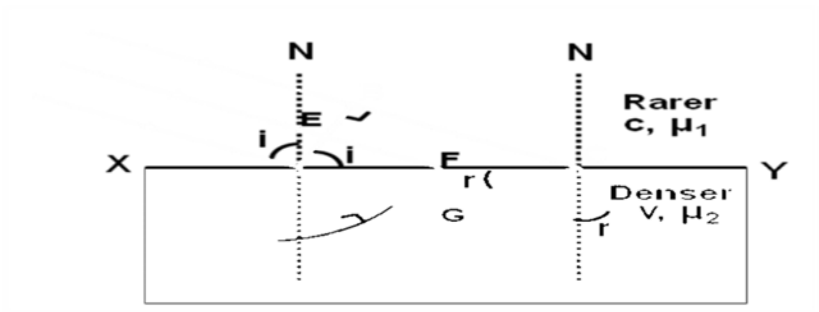
Laws of Reflection at a Plane Surface (On Huygens' Principle):



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

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

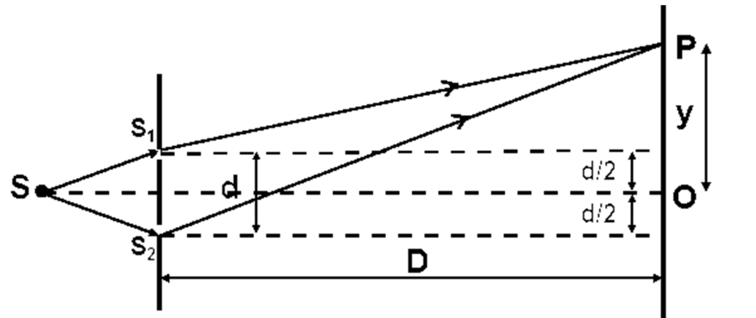
Laws of Refraction at a Plane Surface (On Huygens' Principle):



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

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

INTERFERENCEOF WAVES



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

$$\Delta = S_2P - S_1P$$

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

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

Path difference=yd/D--------------(1)

Condition for constructive interference , path difference =nλ

Yd/D=nλ y=nλD/d------------------(2)

Y_1=λD/d y_2=2λD/d Fringe width β= y_2_y_1

β=λD/d

Condition for destructive interference,path difference=(2n-1)λ/2

Yd/D =(2n-1)λ/2 y_1=λD/2d y_2=3 λD/2d

Fringe width β= y_2_y_1**β=λD/d**

Comparison of intensities of maxima and minima:

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

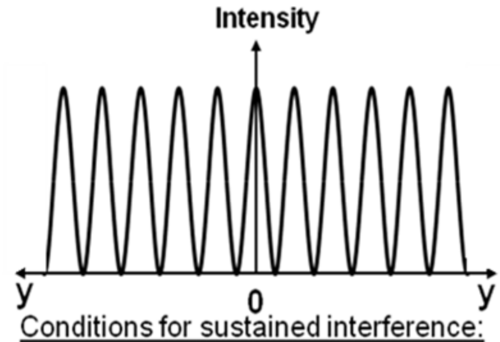
Relation between Intensity (I), Amplitude (a) of the wave and Width (w) of the slit:

$I \propto a^2$

$a \propto \sqrt{w}$

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

Distribution of Intensity:

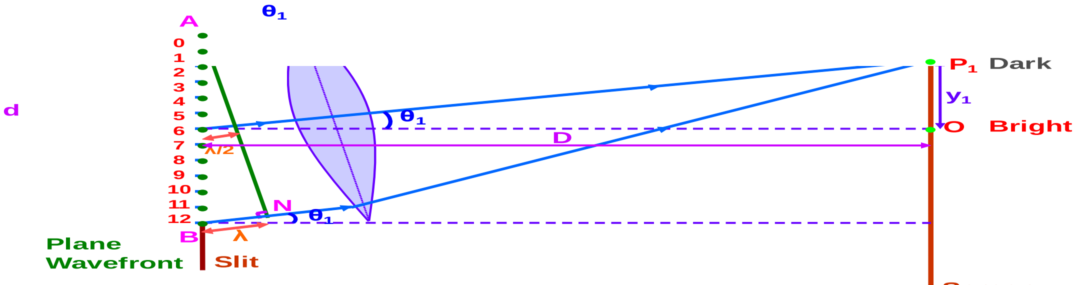


Conditions for sustained interference:

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

DIFFRACTION OF LIGHT AT A SINGLE SLIT ;

Width of Central Maximum:



$y_1 = D \lambda / d$

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

$\beta_0 = 2D \lambda / d$

For n^{th} secondary minimum, path difference $d\sin\Theta_n = n\lambda$

$\sin\Theta_n = n\lambda/d$ $\Theta_n = n\lambda/d$

For n^{th} secondary maximum path difference $d\sin\Theta_n = (2n-1)\lambda/2$

$\sin\Theta_n = (2n-1)\lambda/2d$ $\Theta_n = (2n-1)\lambda/2d$

Fresnel's Distance:

$y_1 = D\lambda/d$

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

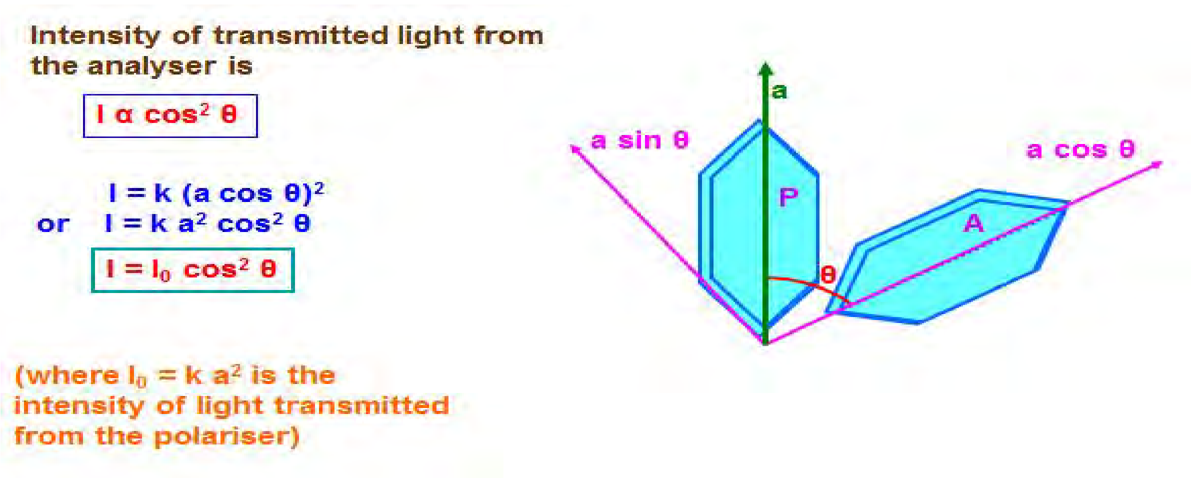
So, $D_F\lambda/d = d$ or $D_F = d^2/\lambda$

POLARISATION OF LIGHT WAVES :

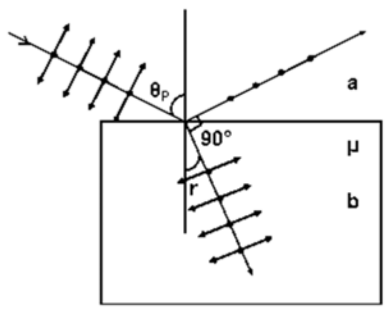
Malus' Law:

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.

(2)



Polarisation by Reflection and Brewster's Law:



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

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

$_a\mu_b = \dfrac{\sin\theta_P}{\sin(90° - \theta_P)}$

$_a\mu_b = \tan\theta_P$

Resolving power of microscope

Resolving power of microscope is the ability of the microscope to show as separate images of two point objects lying close to each other.

Resolving power = 2n sinΘ/λ

nsinΘ is called numerical aperture of the microscope.

Resolving power of telescope

Resolving power of telescope is its ability to show distinctly the images of two distant objects lying close by.

Resolving power =D/1.22λ D is the diameter of the objective

QUESTIONS

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

2 Why a concave mirror is preferred for shaving?
Enlarged VIRTUAL

3 Mirrors in search lights are parabolic and not spherical. Why?
Produce intense parallel beam) eliminating spherical aberration

4 Using the mirror formula show that a virtual image is obtained when an object is placed in between the principal focus and pole of the concave mirror. $\frac{1}{v}=\frac{1}{u}-\frac{1}{f}$ u<f $\Rightarrow \frac{1}{u}>\frac{1}{f}\Rightarrow v$ is +ve)

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

6 Find the position of an object, which when placed in front of a concave mirror of focal length 20cm, produces a virtual image which is twice the size of the object.
Ans. 10cm

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

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

REFRACTION AND LENSES

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

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

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

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

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

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

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

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

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

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

Hence v is always -ve. that is virtual

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

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

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

Ans. n images but less sharp

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

Ans. 4f, -f

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

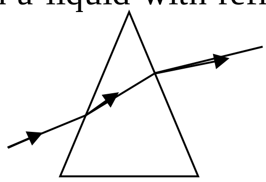
Find n by Snell's law and then find $c=41.14^0$

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

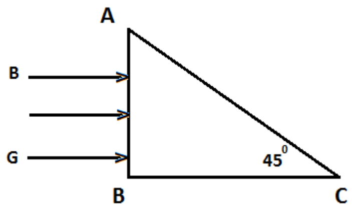
Ans. 0.125m, 0.5m)

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

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



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

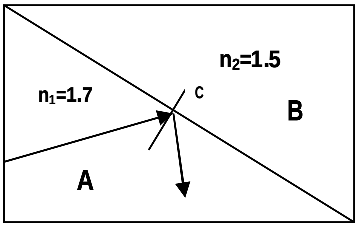


(Hint Calculate the critical angle for each and if the angle of incidence on the surface AC is greater, then TIR will take place.)

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

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

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

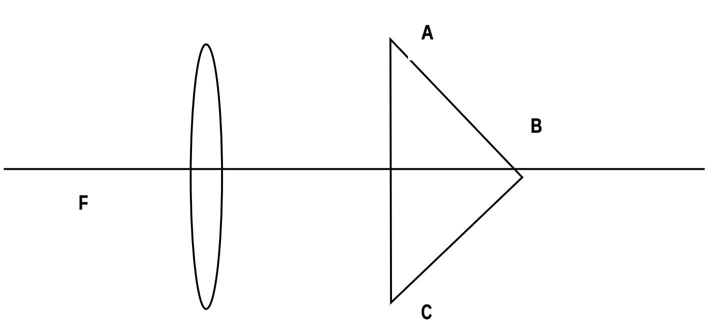


Ans. Use $SinC = \frac{n_r}{n_d} = 0.88$ *and* C=61.7^0 so i=61.8^0 no for TIR ray of light must travel from denser to rarer from B to A)

22 The velocity of light in flint glass for wavelengths 400nm and 700nm are 1.80x10^{8}m/s and 1.86x10^8 m/s respectively. Find the minimum angle of deviation of an equilateral prism made of flint glass for the given wavelengths.

(For 400nm D=52^0 and for 700nm D=48^0)

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



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

OPTICAL INSTRUMENTS
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 5

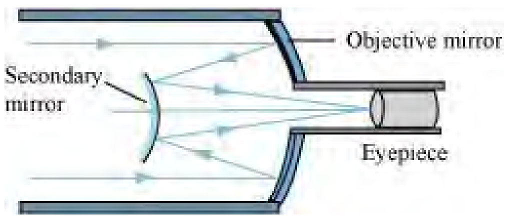
   Final image in a compound microscope? Which of these is usually preferred and why?

   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.

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. Cassegranian telescope uses two mirrors as shown in Fig. Sucha telescope is built with the mirrors20 mm apart. If the radius of curvature of the large mirror is 220mm and the small mirror is 140mm, where will the final image of an object at infinity be? The following figure shows a Cassegranian telescope consisting of a concave mirro rand 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, $f_1 = \frac{R_1}{2} = 110$ mm
Radius of curvature of the secondary mirror, R_1=140 mm

Hence, focal length of the secondary mirror, $f_2 = \frac{R_2}{2} = \frac{140}{2} = 70$ 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, $u = f_1 - d$

$= 110 - 20$

$= 90$ 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 formed 315 mm away from the secondary mirror.

5

DEFECTS OF VISION

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

Ans – The power of the spectacles used by the myopic person, $P = -1.0$ D

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

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

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

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

5

Huygens 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 Huygens's construction draw a figure showing the propagation of a plane wave reflecting at the interface of the two media. Show that the angle of incidence is equal to the angle of reflection. 3

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

Interference

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

2. How the angular separation of interference fringes in young'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 0.1°.What is the spacing between the two slits? 2

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

4. If the path difference produced due to interference of light coming out of two slits for yellow colour of light at a point on the screen be $3\lambda/2$, 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 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

10 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 5×10^{-2} m towards the slits, the charge in fringe width is 3×10^{-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 $\times 10^{-2}$ m

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

11. 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 Φ

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

12. 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? 5

(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) $\frac{S}{d} < \frac{\lambda}{a}$

13. 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)

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

14. 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. 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.

4. 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**

5. 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°

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

2. 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
3. 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
4. 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)

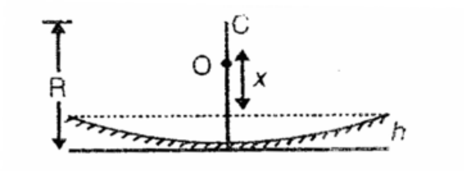
VERY SHORT ANSWER QUESTIONS (1 MARK)

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)

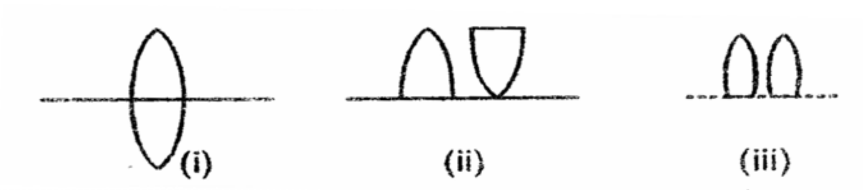
1. Water is poured into a concave mirror of radius of curvature 'R' up to a height h as shown in figure 1. What should be the value of x so that the image of object 'O' is formed on itself? 2

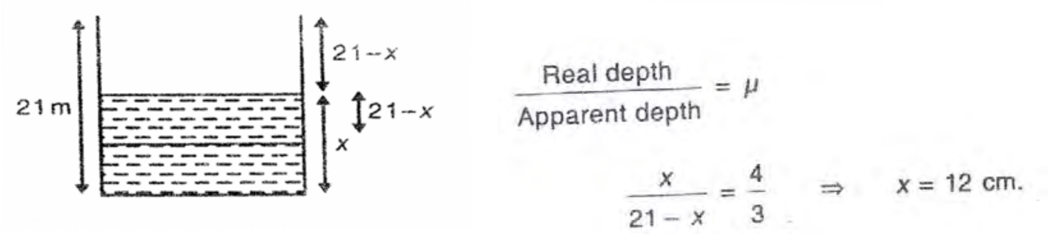
Fig 1 Fig 2



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

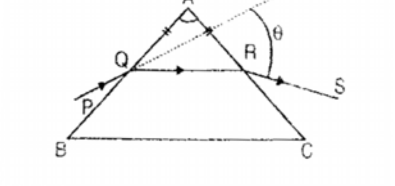




4. How much water should be filled in a container 21cm in height, so that it appears half filled when viewed from the top of the container $\left({}^{a}\mu_{\omega} = 4/3\right)$? 2

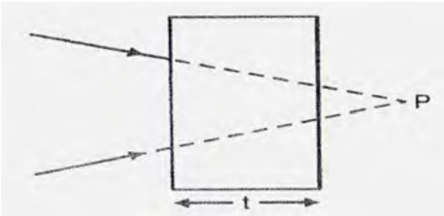
5. A ray PQ incident on the refracting face BA is refracted in the prism BAC as shown in figure and emerges from the other refracting face AC as RS such that AQ= AR. If the angle, of prism A= 60° and μ of material of prism is $\sqrt{3}$ then find angle θ. 2

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



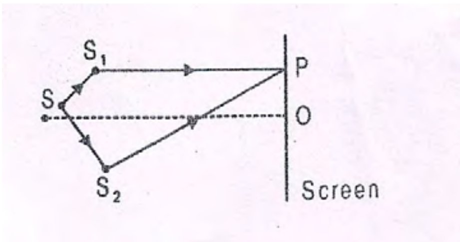
SHORT ANSWER QUESTIONS (3 MARKS)

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



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

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



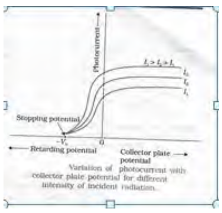
7. DUAL NATURE OF MATTER & RADIATIONGIST

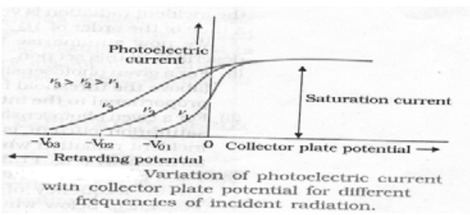
- The elementary particle in an atom having negative charge of magnitude 1.6 x 10^{-19} C and mass of 9.1 x 10^{-19} kg is called electron.
- There are four types of electron emission, namely, Thermionic Emission, Photoelectric Emission, Field Emission and secondary emission.
- The minimum energy required by an electron to escape from the metal surface is called work function.
- Work function is conveniently expressed in electron volts (e V).
- One electron volt is the energy gained or lost by an electron while passing through a potential difference of one volt.
- The phenomenon of emission of electrons from metal surface when suitable high frequency radiation incidents on it is called photoelectric effect. The electrons thus emitted are called photo electrons.
- The electric current in the circuit constituting the photo electrons is called photoelectric current. It depends on the intensity of incident radiation, potential difference applied between the two electrodes and the nature of the material.

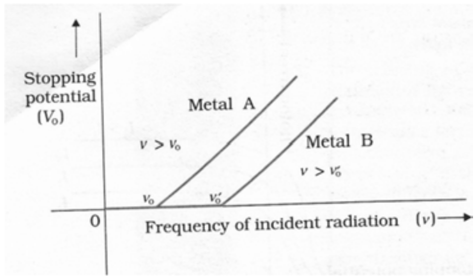
- The minimum negative voltage required to stop completely the photo electric current is called stopping potential.
- The frequency of incident radiation below which no photo electric effect takes place is called threshold frequency.
- Laws of photoelectric effect:

1. The photoelectric emission is an instantaneous process.
2. For a given metal and frequency of radiation the photoelectric current is directly proportional to the intensity of incident radiation.
3. For a given metal if the frequency of incident radiation below its threshold frequency then no photoelectric effect takes place.
4. The maximum kinetic energy of photo electron is directly proportional to the frequency of incident radiation and independent of its intensity.

EXPERIMENTAL STUDY OF PHOTOELECTRIC EFFECT







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

- The light propagates in the form of wave and interacts with matter in the form of discrete packets of energy called quantum of energy. One quantum of light radiation is called PHOTON.
- A photon travels with the speed of light
- Frequency of photon does not change as it travels from one medium to another but wavelength changes as speed changes.
- The rest mass of photon is zero as the photon can not exist in rest.
- Energy of photon $E = h\nu = hc/\lambda$
- Momemntum of photon is $p = mc = h\nu/c = h/\lambda$
- The equivalent mass of photon is $m = E/c^2 = h\nu/c^2$.
- Einstein's photo electric equation: $K_{max} = h\nu - \varphi_0$ or $eV_0 = h\nu - \varphi_0$ where $\varphi_0$is the work function of metal.

- 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.
- 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.
- The De Broglie wave length (λ) associated with the moving particle is related to its moment p as: $\lambda = h/p = h/mv$.
- An equation for the De Broglie wavelength of an electron accelerated through a potential V.
- Consider an electron with mass 'm' and charge 'e' accelerated from rest through a potential V.

$K = eV$

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

$P^2 = 2mK$

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

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

Substituting numerical values of h, m and e

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

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? 1

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 5200Á. Will photo electric emission takes place, if an ultra violet radiation of one watt power is incident on it? 1

8 Name the element with highest work function and also the element with

lowest work function.
Highest work function – Platinum (5.65eV)
Lowest work function – Caesium (2.14eV) 2

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

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

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

EINSTEIN'S PHOTO ELECTRIC EQUATION :ENERGY QUANTUM OF RADIATION

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

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

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

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

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 x 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 x 10^{-8} N

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

20 Illuminating the surface of a certain metal alternately with light of wave lengths 0.35µm 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 4000Ǻ, 4800Ǻ, 6000Ǻ & 7000Ǻ, each of intensity 1.5mW/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.

Ans :E_1 = 3.1eV, E_2 = 2.58eV, E_3 = 2.06eV, E_4 = 1.77eV 3

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 x 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 x 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 = 9.1x 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^o

2 Matter waves associated with electrons could be verified by crystal diffraction experiments .Why? 1

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 x 10^6 m/s

6 Find the ratio of wavelength of a 10 k eV photon to that of a 10 keV electron.

Ans: 10 (Hint: λ_{photon} = 1.24 A^0, $\lambda_{electron}$ = 0.1227 A^0) 2

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?

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. 2

In the sub- atomic world, masses of the particles are extremely small leading to a wave length that is measurable.

9 Show that Bohr's second postulate 'the electron revolves around the nucleus only in certain fixed orbits without radiating energy can be explained on the basis of de Broglie hypothesis of wave nature of electron. 2

Ans. The de Broglie wavelength for electron in orbit mvr = nh/ 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

$$\lambda \;\alpha\; \frac{1}{\sqrt{\mathrm{v}}}, \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{\mathrm{V}_2}{\mathrm{V}_1}} = \frac{\lambda}{\lambda_2} = \sqrt{\frac{4}{1}} \Rightarrow \lambda_2 = \frac{\lambda}{2}$$

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

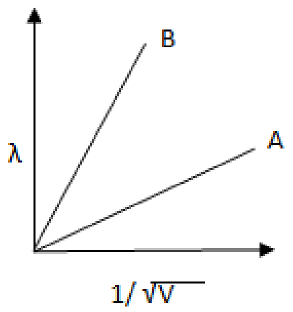
Ans: V = 150.6 V

12 An electron, an alpha particle and a proton have the same kinetic energy, which one of these particles has (i) the shortest and (ii) the largest, de-Broglie wavelength? 2

Ans:

$$\lambda = \frac{h}{\sqrt{2mE_k}} \;\alpha\; \frac{1}{\sqrt{\mathrm{m}}}$$

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?



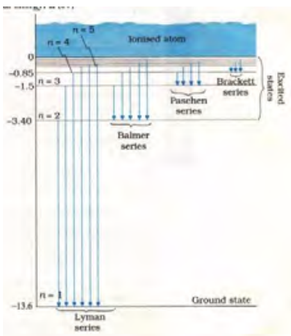
2

Ans: Slope of the graph is h/√2me.

Slope of A is smaller, so A represents heavier particle.

8. ATOMS & NUCLEI

GIST	
Thomson's model of atom- Every atom consists of 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}, which is very small as compared to the size of the atom which is of the order of 10^{-10}m. iii) The atomic nucleus is surrounded by certain number of electrons. As atom on the whole is electrically neutral, the total negative charge of electrons surrounding the nucleus is equal to total positive charge on the nucleus. iv) These electrons revolve around the nucleus in various circular orbits as do the planets around the sun. 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	$r_0 = \frac{2kZe^2}{(½)mv^2}$
Impact parameter of the alpha particle	$b = \frac{kZe^2 \cot\theta/2}{(½)mv^2}$
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	$r = e^2/4\pi\epsilon_0 mv^2$, $v = 2\pi ke^2/nh$, $r = \frac{n^2h^2}{4\pi^2mke^2}$ Type equation here.
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 $h/2\pi$	$L = mvr = nh/2\pi$, $n = 1,2,3,\ldots$
Wave number $\bar{\nu}$ 	$1/\lambda = R(1/n_1^2 - 1/n_2^2)$ $R = 1.097 * 10^{+7} m^{-1}$
Atomic Number (Z)	No of protons in a nucleus
Mass Number (A) Number of neutrons	No. of nucleons(protons + neutrons) in a nucleus A-Z
Nuclear radius	$R = R_0 A^{1/3}$

Nuclear density	P= $3m/4\pi R_0^3$
Isotopes	Same Z & different A Ex, $^1H_2$,$^1H_3$,$^1H_1$, & C^{12},C^{14},C^{16}
Isobars	Same A & different Z [$_{18}Ar^{40}$,$_{20}Co^{40}$] & ($_1H^3$, $_2H^3$)
Isotones	Same no. of neutrons Mass of neutrons – $_1H^3$, $_2He^4$
Mas defect Δm	Total Mass of nucleons – mass of nucleus
Binding energy E_b	E=Δ m Δ 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 fusion	Fusing of lighter nuclei to form a heavy nucleus.This process takes place in Stars & Hydrogen bomb. Controlled Thermonuclear Fusion In a fusion reactor-high particle density is required high plasma temperature of 10^9Ka long confinement time is required

QUESTIONS

ALPHA PARTICLE SCATTERING

1. What is the distance of closest approach when a 5MeV proton approaches a gold nucleus (Z=79) (1)

Ans $r_0 = \frac{1}{4\pi\varepsilon_\circ}\frac{Ze^2}{F_2} = 2.3 \times 10^{-14}$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 2^{nd} level to 1^{st} and highest level to second level. $E_{2-1} = R_H$ c[$1/n_1^2 - 1/n^2$] = ¾ R_H c

$E\infty - E1 = R_H\, c(1/2^2 - 1/\infty) = R_H\, c / 4$ (3)

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)

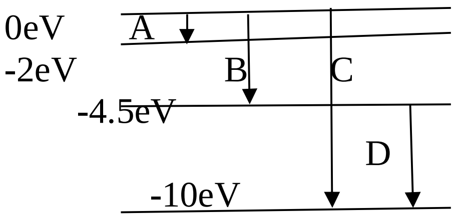
***Ans**: K.E=-E=13.6 eV, P.E=-2K.E=-27.2 eV*

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**: $E=hc/\lambda=4.5eV$, transition B $E \alpha 1/\lambda$, transition A*

7. The spectrum of a star in the visible & the ultraviolet region was observed and the wavelength of some of the lines that could be identified were found to be 824Å, 970Å, 1120Å, 2504Å, 5173Å & 6100Å.Which of these lines cannot belong to hydrogen spectrum? (3)

***Ans**: 970Å*

(3)

9. What is the energy possessed by an ē for n= ∞?

Ans E=0 (1)

10. Calculate the ratio of wavelength of photon emitted due to transition of electrons of hydrogen atom from

i) Second permitted level to first level

ii) Highest permitted level to second level (3)

11. The radius of inner most electron orbit of H_2 atom is 5.3×10^{-11}m. What are radii for n=2, 3, 4? Ans: $r_n = n^2 r_1$(3)

<u>COMPOSITION OF NUCLEUS</u>

1. What is the relation between the radius of the atom & the mass number? (1)

***Ans**: size α $A^{1/3}$*

2. What is the ratio of the nuclear densities of two nuclei having mass numbers in the ratio 1:4?

***Ans**: 1:1* (1)

3. How many electrons, protons & neutrons are there in an element of atomic number (Z) 11 & mass number (A) 24?

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

(2)

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 MeVHence* $^{56}Fe_{26}$

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=1/9λ (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, λ=.0693/s, τ=1/λ=14.43s, N=1/16(N_0/8) →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)

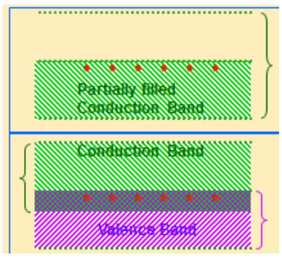
7. 4 nuclei of an element fuse together to form a heavier nucleus .If the process is accompanied by release of energy, which of the two: the parent or the daughter nuclei would have higher binding energy per nucleon. Justify your answer. (2)

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)

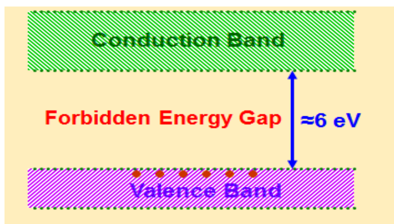
9. ELECTRONIC DEVICES

GIST

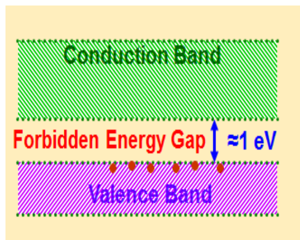
- In metals, the conduction band and valence band partly overlap each other and there is no forbidden energy gap.
- In insulators, the conduction band is empty and valence band is completely filled and forbidden gap is quite large = 6 eV. No electron from valence band can cross over to conduction band 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

Distinction between Intrinsic and Extrinsic Semiconductor

Intrinsic		Extrinsic	
1	It is pure semiconducting material and no impurity atoms are added to it	1	It is prepared by doping a small quantity of impurity atoms to the pure semiconducting material.
2	Examples are crystalline forms of pure silicon and germanium.	2	Examples are silicon and germanium crystals with impurity atoms of arsenic, antimony, phosphorous etc. or indium, boron, aluminum etc.
3	The number of free electron in conduction band and the number of holes in valence band is exactly equal and very small indeed.	3	The number of free electrons and holes is never equal. There is excess of electrons in n-type semiconductors and excess of holes in p-type semiconductors.

4	Its electrical conductivity is low	4	Its electrical conductivity is high.
5	Its electrical conductivity is a function of temperature alone.	5	Its electrical conductivity depends upon the temperature as well as on the quantity of impurity atoms doped in the structure.

Distinction between n-type and p-type semiconductors

n-type semiconductors		p-type semiconductors	
1	It is an extrinsic semiconductors which is obtained by doping the impurity atoms of Vth group of periodic table to the pure germanium or silicon semiconductor.	1	It is an intrinsic semiconductors which is obtained by doping the impurity atoms of III group of periodic table to the pure germanium or silicon semiconductor.
2	The impurity atoms added, provide extra electrons in the structure, and are called donor atoms.	2	The impurity atoms added, create vacancies of electrons (i.e. holes) in the structure and are called acceptor atoms.
3	The electrons are majority carriers and holes are minority carriers.	3	The holes are majority carriers and electrons are minority carriers.
4	The electron density (n_e) is much greater than the hole density (n_h)i.e. n_e>>(n_h)	4	The hole density (n_e) is much greater than the electron density (n_h)i.e. n_h>> n_e
5	The donor energy level is close to the conduction band and far away from valence band.	5	The acceptor energy level is close to valence band and is far away from the conduction band.
6	The Fermi energy level lies in between the donor energy level and conduction band.	6	The Fermi energy level lies in between the acceptor energy level and valence band.

<u>P-n junction diode</u>

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.

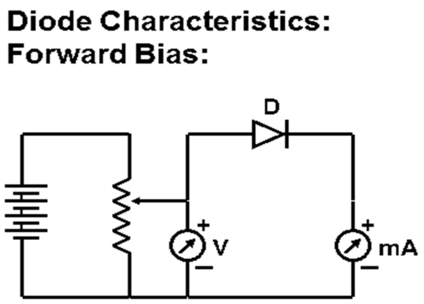
In equilibrium state, there is no current across p-n junction and potential barrier across p-n junction has maximum value.
The width of the depletion region and magnitude of barrier potential depends on the nature of semiconductor and doping concentration on two sides of p-n junction.

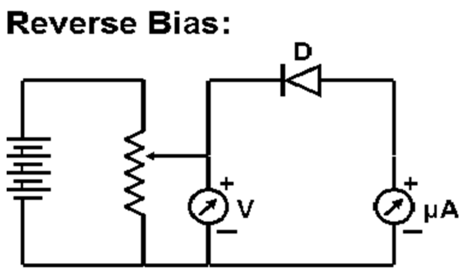
Forward Bias

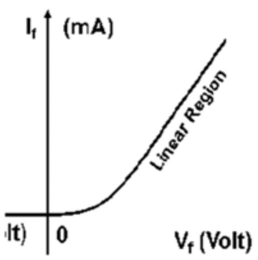
P-n junction is FB when p-type connected to the +ve of battery and n-type connected to –ve battery
Potential barrier is reduced and width of depletion layer decreases.

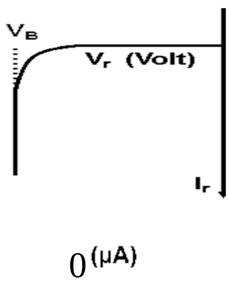
Reverse Bias

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.

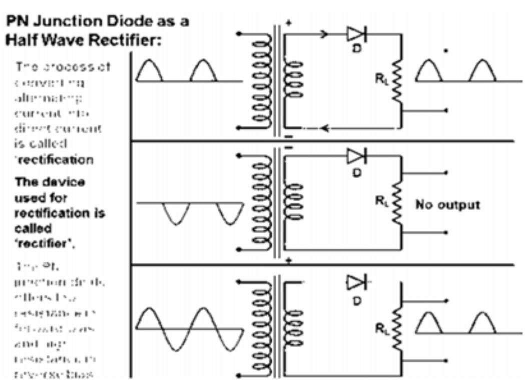


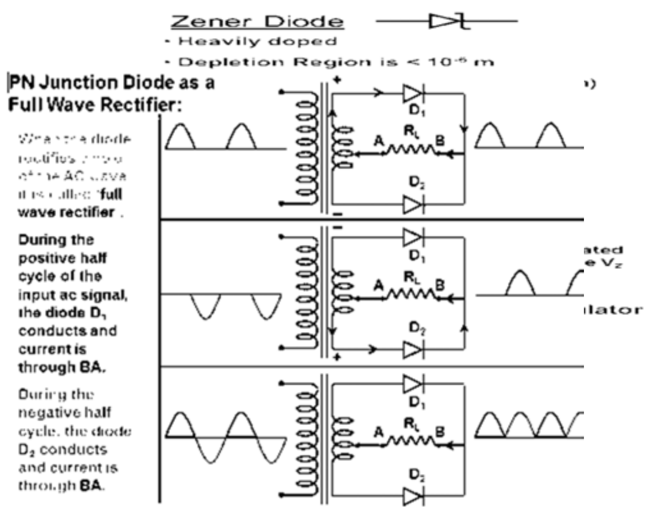


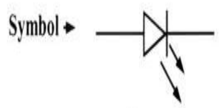
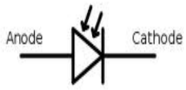
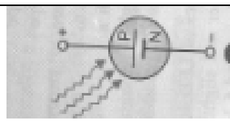
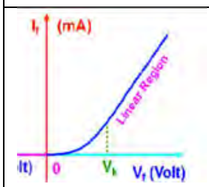
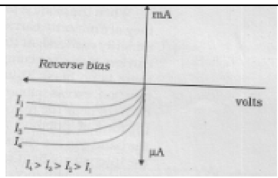
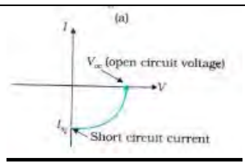




rectification





LED	PHOTODIODE	SOLARCELL
		
Forward biased	Reverse biased	No external baising,It generates emf when solar radiation falls on it.
Recombination of electrons and holes take place at the junction and emits e m radiations	Energy is supplied by light to take an electron from valence band to conduction band.	Generation of emf by solar cells is due to three basic process generation of e-h pair,separation and collection
It is used in Burglar alarm, remote control	It is used in photo detectors in communication	It is used in satellites,space vechicles calculators.
		

QUESTIONS

SEMICONDUCTORS

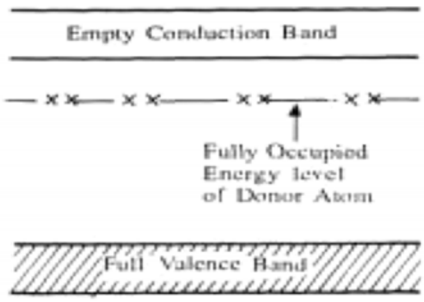
1. What is the order of energy gap in an intrinsic semiconductor? (1)
2. How does the energy gap vary in a semiconductor when doped with penta - valent element? (1)
3. How does the conductivity change with temperature in semiconductor? (1)
4. What type of semiconductor we get when: Ge is doped with Indium? Si is doped with Bismuth? (1)
5. In a semiconductor concentration of electron is $8 \times 10^{13} cm^{-3}$ and holes $5 \times 10^{12} cm^{-2}$: is it P or N type semiconductor? (1)
6. Draw energy gap diagram of a P Type semiconductor? (1)
7. What is Fermi energy level? (1)
8. Energy gap of a conductor, semiconductor, insulator are E1, E2, E3 respectively. Arrange them in increasing order. (1)
9. Name the factor that determines the element as a conductor or semiconductor? (1)
10. Why semiconductors are opaque to visible light but transparent to infrared radiations? (2)

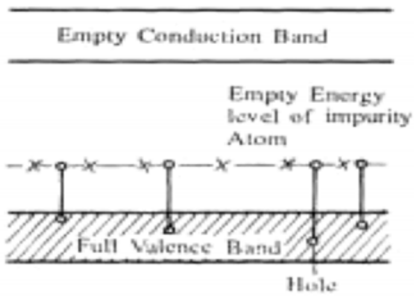
Ans: The photons of infrared radiation have smaller energies, so they fail to excite the electrons in the valence band. Hence infrared radiations pass through the semiconductors as such; i.e. a semiconductor is transparent to infrared radiation

11. The ratio of number of free electrons to holes n_e/n_h for two different materials A and B are 1 and <1 respectively. Name the type of semiconductor to which A and B belongs. (2)

Ans: If $n_e/n_{h=1}$. Hence A is intrinsic semiconductor. If $n_e/n_h<1$, $n_e<n_h$ hence B is P-type.

12. Differentiate the electrical conductivity of both types of extrinsic semiconductors in terms of the energy band picture. (2)



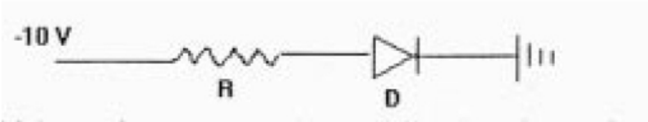


P-N JUNCTION DIODE

1. How does the width of depletion layer change, in reverse bias of a p-n junction diode? (1)

2. Draw VI characteristic graph for a Zener diode? (1)

3. In a given diagram, is the diode reverse (or) forward biased? (1)



Ans: Reverse biased.

4. Why Photo diode usually operated at reverse bias? (2)

5. State the factor which controls wave length and intensity of light emitted by LED. (2)

Ans: (i) Nature of semi-conductor

(ii) Forward Current

6. With the help of a diagram show the biasing of light emitting diode. Give two advantages over conventional incandescent Lamp. (2)

Ans: Mono chromatic, Consume less power.

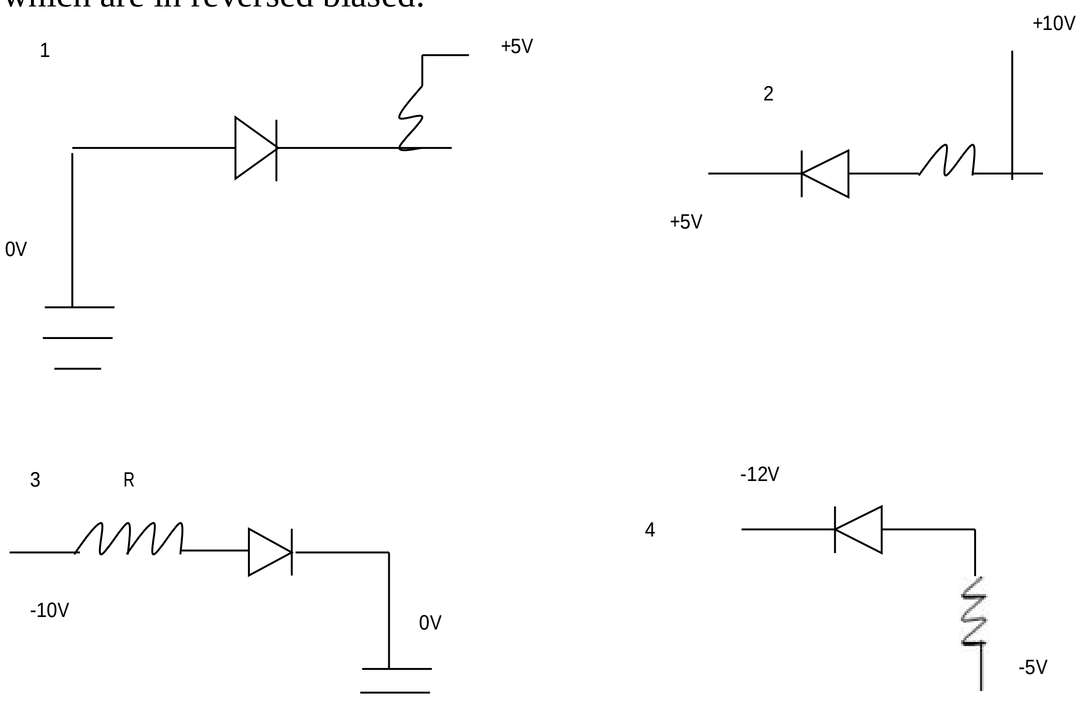
8. Draw a circuit diagram to show, how is a photo diode biased? (2)

9. Pure SI at 300K have equal electron and holes concentration 1.5×10^{16} per m^3. Doping by Indium increases hole concentration to 4.5×10^{22} per m^3. Calculate new electron concentration.

Ans: $n_e n_h = n_i^2$ (2)

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

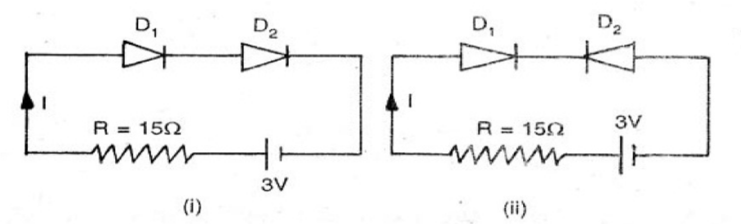
11. In the following diagram, identify the diodes which are in forward biased and which are in reversed biased.



12. 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) $n_e n_h = n_i^2 \Rightarrow n_h = \underline{6x10^8\ x6x10^8 = \quad}\ 4x10^4$ $perm^2$

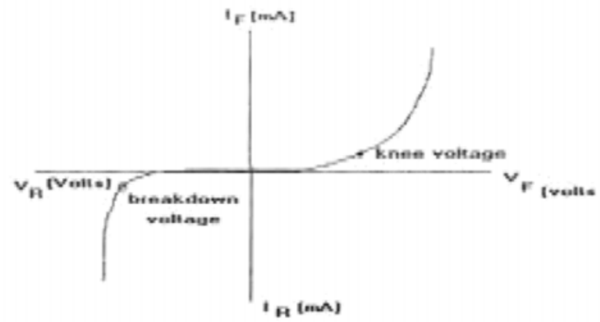
13. Determine the current through resistance "R" in each circuit. Diodes D1 and D2 are identical and ideal. 2



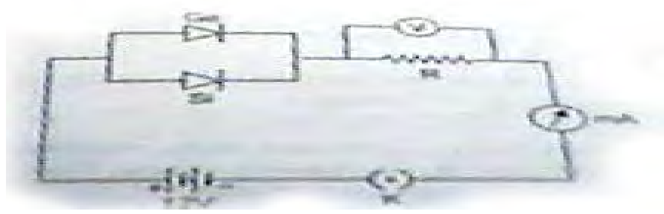
Ans: In circuit (i) Both D1 and D2 are forward biased hence both will conduct current and resistance of each diode is "0".Therefore I = 3/15 = 0.2 A

(i) Diode D1 is forward bias and D2 is reverse bias, therefore resistance of diode D1 is "0" and resistance of D2 is infinite. Hence D1 will conduct and D2 do not conduct. No current flows in the circuit.

14. From the given graph identify the knee voltage and breakdown voltage. Explain? (2)



15. 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.

16. A Zener diode has a contact potential of .8Vin the absence of biasing. It undergoes breakdown for an electricfield of 10V/m at the depletion region of p-n junction. If the width of the depletion region is 2.4μm? What should be the reverse biased potential for the Zener breakdown to occur? (2)

17. 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.

18. On the basis of energy band diagrams, distinguish between metals, insulators and semiconductors. (3)

SPECIAL DEVICES

1. A photodiode is fabricated from a semiconductor with a band gap of 2.8eV.can it Can it detect a wavelength of 600nm?Justify? (2)

Ans: Energy corresponding to wavelength 600 nm is

$$E=hc/\lambda = \frac{6.6x10^{-34} \text{ x } 3x10^{8}}{600x10^{-9}} \text{ joule} = 0.2eV.$$

It cannot detect because $E<E_g$

2. Which special type of diode acts as voltage regulator? Give the symbol. Draw its V-I characteristics. (3)

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 length 2 a at the midpoint of the line joining the two charges.
4) Sketch the electric lines of force due to point charges $q > 0$, $q < 0$ and for uniform field.
5) Define electric flux. Give its S.I unit and dimensional formula.
6) Two point charges 4μc and -2μc are separated by a distance of 1 m in air. At what point on the line joining the charges is the electric potential zero?
7) Depict the equipotential surfaces for a system of two identical positive point charges placed at distance d apart.
8) Deduce the expression for the potential energy of a system of two point charges q_1 and q_2 brought from infinity to that points r_1 and r_2.

3 MARKS

9) Derive an expression for electric field intensity at a point on the axial line and on the equatorial line of an electric pole.
10) Derive an expression for torque acting on an electric dipole in a uniform electric filed.
11) Derive an expression for total work done in rotating an electric dipole through an angle ‘θ’ in uniform electric field.
12) A sphere ‘S_1’ of radius ‘r_1’ encloses a charge ‘Q’. If there is another concentric sphere S_2 of the radius r_2 ($r_2 > r_1$) and there be no additional charges between S_1 and S_2, find the ratio of electric flux through S_1 and S_2.
13) State Gauss’s Theorem in electrostatics. Using this theorem, find the electric field strength due to an infinite plane sheet of charge.
14) State Gauss' theorem. Apply this theorem to obtain the expression for the electric field intensity at a point due to an infinitely long, thin, uniformly charged straight wire.

15) Using Gauss's theorem, show mathematically that for any point outside the shell, the field due to a uniformly charged thin spherical shell is the same as if the entire charge of the shell is concentrated at the centre. Why do you expect the electric field inside the shell to be zero according to this theorem?

16) Deduce an expression for the electric potential due to an electric dipole at any point on its axis. Mention one contrasting feature of electric of a dipole at a point as compared to that due to single charge.

17) Define dielectric constant in terms of the capacitance of a capacitor.

5 MARKS

18) Give the principle and working of a Van de Graff generator. With the help of a labelled diagram, describe its construction and working. How is the leakage of charge minimised from the generator?

19) Briefly explain the principle of a capacitor. Derive an expression for the capacitance of a parallel plate capacitor, whose plates are separated by a dielectric medium.

20) Derive an expression for the energy stored in a parallel plate capacitor with air between the plates. How does the stored energy change if air is replaced by a medium of dielectric constant 'K'? ; Also show that the energy density of a capacitor is.

21) A parallel-plate capacitor is charged to a potential difference V by a dc source. The capacitor is then disconnected from the source. If the distance between the plates is doubled, state with reason how the following change

(i) Electric field between the plates

(ii) Capacitance, and

(iii) Energy stored in the capacitor

22) Explain the underlying principle of working of a parallel plate capacitor. If two similar plates, each of area 'A' having surface charge densities '+ σ' & '-σ' are separated by a distance 'd' in air, write expressions for (i) the electric field at points between the two plates, (ii) the potential difference between the plates & (iii) the capacity of the capacitor so formed

23) A parallel plate capacitor is charged by a battery and the battery remains connected, a dielectric slab is inserted in the space between the plates. Explain what changes if any , occur in the values of

(I) Potential difference between the plates

(II) Electric field between the plates

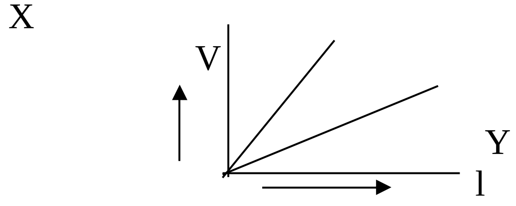
(III) Energy stored in the capacitor.

UNIT II

CURRENT ELECTRICITY

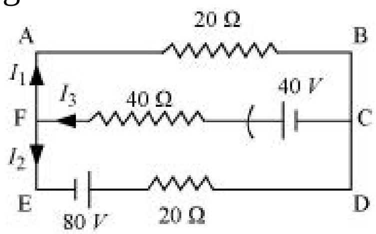
2 MARKS

1. Two wires 'A' & 'B' are of the same metal and of the same length. Their areas of cross-section are in the ratio of 2:1. if the same potential difference is applied across each wire in turn, what will be the ratio of the currents flowing in 'A' & 'B'?
2. Explain, with the help of a graph, the variation of conductivity with temperature for a metallic conductor.
3. Draw V-I graph for ohmic and non-ohmic materials. Give one example for each.
4. Explain how does the resistivity of a conductor depend upon (i) number density 'n' of free electrons, & (ii) relaxation time't'.
5. Define the term 'temperature coefficient of resistivity'. Write its SI unit. Plot a graph showing the variation of resistivity of copper with temperature.
6. A cell of emf (E) and internal resistance (r) is connected across a variable external resistance (R) Plot graphs to show variation of (i) E with R (ii) terminal p.d. of the cell (V) with R.
7. Explain how electron mobility changes from a good conductor (i) when temperature of the conductor is decreased at constant potential difference and (ii) applied potential difference is doubled at constant temperature.
8. Write the mathematical relation between mobility and drift velocity of charge carriers in a conductor. Name the mobile charge carriers responsible for conduction of electric current in: (i) an electrolyte, & (ii) an ionised gas.
9. Define drift velocity. Establish a relation between current & drift velocity.
10. Define the term current density of a metallic conductor. Deduce the relation connecting current density 'J' & the conductivity 'σ' of the conductor when an electric field 'E' is applied to it.
11. Why do we prefer potentiometer to compare the e.m.f of cells than the voltmeter. Why?
12. State Kirchhoff's rules of current distribution in an electric network.
13. The variation of potential difference "V' with length 'l' in the case of two potentiometers 'X' & 'Y' is as shown in figure. Which one of these two will you prefer for comparing 'emf's of two cells and why?



3 MARKS

14. Draw a circuit diagram using a metre bridge and write the necessary mathematical relation used to determine the value of an unknown resistance. Why cannot such an arrangement be used for measuring very low resistance?
15. With the help of a circuit diagram, explain in brief the use of a potentiometer for comparison of 'emf's of two cells.
16. Prove that the current density of a metallic conductor is directly proportional to the drift speed of electrons.
17. A number of identical cells, n, each of emf E, internal resistance r connected in series are charged by a d.c. source of emf E′, using a resistor R.
    (i) Draw the circuit arrangement.
    (ii) Deduce the expressions for (a) the charging current and (b) the potential difference across the combination of the cells.
18. Derive the principle of wheatstone bridge using Kirchoff's law.
19. State Kirchhoff's rules of current distribution in an electrical network.
    Using these rules determine the value of the current I1 in the electric circuit given below.



20. Write the mathematical relation for the resistivity of material in terms of relaxation time, number density and mass and charge of charge carriers in it. Explain,using this relation, why the resistivity of a metal increases and that of semi-conductor decreases with rise in temperature.
21. Calculate the value of the resistance R in the circuit shown in the figure so that the current in the circuit is 0·2 A. What would be the potential difference between points A and B?

UNIT III

MAGNETIC EFFECTS OF CURRENT AND MAGNETISM

2 MARKS

1. A circular coil of radius 'R' carries a current 'I'. Write the expression for the magnetic field due to this coil at its centre. Find out the direction of the magnetic field.
2. Write the expression for the force on the charge moving in a magnetic field. Use this expression to define the SI unit of magnetic field.
3. Define magnetic susceptibility of a material. Name two elements, one having positive susceptibility and the other having negative susceptibility. What does negative susceptibility signify?
4. Define the term magnetic dipole moment of a current loop. Write the expression for the magnetic moment when an electron revolves at a speed around an orbit of radius in hydrogen atom..
5. Explain with the help of a diagram the term 'magnetic declination' at a given place.
6. Define the term 'angle of dip'. What is the value of the angle of dip at the magnetic equator? What does it mean?
7. Two wires of equal lengths are bend in the form of two loops. One of the loop is square shaped where as the other loop is circular. These are suspended in a uniform magnetic field and the same current is passed through them. Which loop will experience greater torque? Give reasons.
8. Explain why steel is preferred for making permanent magnets while soft iron is preferred for making electromagnets.
9. Draw diagram to show behavior of magnetic field lines near a bar of 1) copper 2) aluminum and 3) mercury cooled at a very low temperature (4.2K)
10. How will the magnetic field intensity at the centre of the circular coil carrying current will change, if the current through the coil is doubled and radius of the coil is halved?
11. What do you mean by current sensitivity of a moving coil galvanometer? On what factors does it depend?
12. Derive an expression for the force experienced by a current carrying straight conductor placed in a magnetic field. Under what condition is this force maximum?

3 MARKS

13. Obtain the force per unit length experienced by two parallel conductors of infinite length carrying current in the same direction. Hence define one ampere.

14. A) If χ -stands for the magnetic susceptibility of a given material, identify the class of materials for which (a) $-1 \geq \chi < 0$, and (b) $0 < \chi < \epsilon$ [ϵ 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'smagnetic moment.
17. With the help of diagram explain how a galvanometer can be converted into an ammeter and a voltmeter.
18. To increase the current sensitivity of a moving coil galvanometer by 50%, its resistance is increased so that the new resistance becomes twice its initial resistance. By what factor does its voltage sensitivity change?

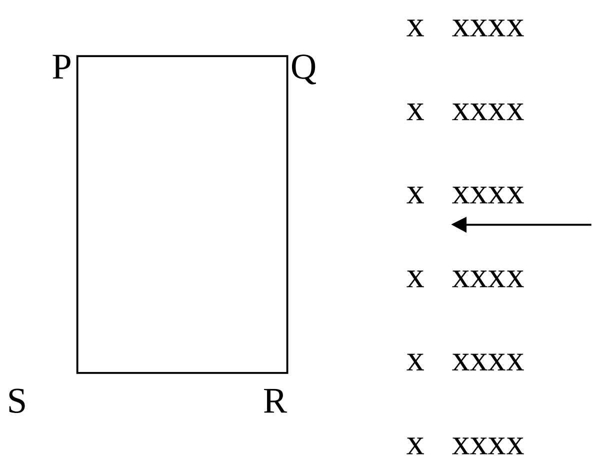
5 MARKS

19. Write an expression for force experienced by a charged particle moving in a uniform magnetic field? With the help of labeled diagram, explain principle and working of a cyclotron. Show that cyclotron frequency does not depend upon the speed of particles. Write its two limitations.
20. State Ampere's Circuital Law. Derive an expression for the magnetic field at a point due to straight current carrying conductor.
21. Derive an expression for the magnetic field at a point along the axis of an air cored solenoid using a Ampere's circuital law.
22. Derive an expression for torque acting on a rectangular current carrying loop kept in a uniform magnetic field B. Indicate the direction of torque acting on the loop.
23. With neat diagram, describe the principle, construction and working of a moving coil galvanometer. Explain the importance of radial field.
24. State Biot Savart Law. Use this law to obtain a formula for magnetic field at the centre of a circular loop of radius R, number of turns N carrying current I. Sketch the magnetic field lines for a current loop clearly indicating the direction of the field.
25. Distinguish the magnetic properties of dia, para- and ferro-magnetic substances interms of (i) susceptibility, (ii) magnetic permeability and (iii) coercivity. Give one example of each of these materials. Draw the field lines

due to an external magnetic field near a (i) diamagnetic, (ii) paramagnetic substance.

UNIT IV
ELECTROMAGNETIC INDUCTION & ALTERNATING CURRENT
2 MARKS

1. How does the self-inductance of an air core coil change, when (i) the number of turns in the coils is decreased & (ii) an iron rod is introduced in the coil.
2. What is the effect on the mutual inductance between the pair of coil when (i) the distance between the coils is increased? (ii) the number of turns in each coil is decreased? Justify your answer in each case.
3. State Lenz's law. Show that it is in accordance with the law of conservation of energy.
4. The closed loop PQRS is moving into a uniform magnetic field acting at right angles to the plane of the paper as shown. State the direction of the induced current in the loop.



5. Define mutual inductance and give its S.I. unit.Write two factors on which the mutual-inductance between a pair of coil depends.
6. What is the power dissipated in an ac circuit in which voltage & current are given by $V = 230 \sin(\omega t + \pi/2)$ and $I = 10 \sin \omega t$?
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. Ana. c. voltage $E=E_0\sin\omega t$ is applied across a pure capacitor of capacitance C. Show mathematically that the current flowing through it leads the applied voltage by a phase angle of $\pi/2$. .
20. Explain the term 'inductive reactance'. Show graphically the variation of inductive reactance with frequency of the applied alternating voltage.

    An a.c. voltage $E=E_0\sin\omega t$ is applied across a pure inductor of inductance L. Show mathematically that the current flowing through it lags behind 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 labelled diagram the principle, construction and working of a transformer. Mention the various energy losses in a transformer? Explain the role of transformer in long distance transmission of power ?
26. With the help of a neat diagram, explain the principle construction and working of an a.c generator.

UNIT V

ELECTROMAGNETIC WAVES

2 MARKS

1. A plane monochromatic light wave lies in the visible region. It is represented by sinusoidal variation with time by the following components of electric field:

   $E_X = 0$, $E_Y = 4 \sin [2\pi/\lambda\ (x - vt)]$, $E_z = 0$

   Where, $v = 5 \times 10^{14}$ Hz and λ is the wave length of light.

   (i) What is the direction of propagation of the wave?

   (ii) What is its amplitude? And

   (iii) Compute the components of magnetic field.
2. Give two characteristics of electromagnetic waves. Write the expression for the velocity of electromagnetic waves in terms of permittivity and magnetic permeability of free space.
3. Find wavelength of electromagnetic waves of frequency 5×10^{19} Hz in free space. Give its two applications.
4. Name the characteristics of e. m. waves that: (i) increases, & (ii) remains constant in e. m. spectrum as one moves from radiowave region towards ultraviolet region.

3 MARKS

5. Which constituent radiation of electromagnetic spectrum is used: (i) in radar? (ii) To photograph internal parts of human body? & (iii) for taking photographs of the sky during night and foggy condition? Give one reason for your answer in each case.

6. Write any four characteristics of e. m. waves. Give two uses of: (i) Radio waves & (ii) Microwaves.
7. Name the following constituent radiations of e. m. spectrum which, (i) produce intense heating effect? (ii) is absorbed by the ozone layer, & (iii) is used for studying crystal structure.
8. Experimental observations have shown: (i) that X-rays travel in vacuum with a speed of 3×10^8 m s^{-1}, & (ii) the phenomenon of diffraction and can be polarized. What conclusion is drawn about the nature of X-rays from each of these observations?
9. Why are infrared radiations referred to as heat waves? Name the radiations which are next to these radiations in e. m. spectrum having: (i) shorter wavelength, & (ii) longer wavelength.
10. The oscillating magnetic field in a plane electromagnetic wave is given by:
    $B_y = 8 \times 10^{-6} \sin [2 \times 10^{11} t + 300 \pi x]$ T
    (i) Calculate the wavelength of the electromagnetic wave &
    (ii) Write down the expression for oscillating electric filed.
11. Identify the following electromagnetic radiation as per the wavelengths given below:
    (a)10^{-3}nm,
    (b)10^{-3}m,
    (c)1nm;
    Write one application of each.
12. Name the constituent radiation of electromagnetic spectrum which
    (a) is used in satellite communication.
    (b) is used for studying crystal structure.
    (c) is similar to the radiations emitted during decay of radioactive nuclei.
    (d) has its wavelength range between 390 nm and 770 nm.
    (e) is absorbed from sunlight by ozone layer.
    (f) produces intense heating effect.
13. What is meant by the transverse nature of electromagnetic waves? Drawdiagram showing the propagation of the an electromagnetic wave along X direction, indicating clearly the directions of oscillating electric and magnetic fields associated with it.

UNIT VI

OPTICS

2 MARKS

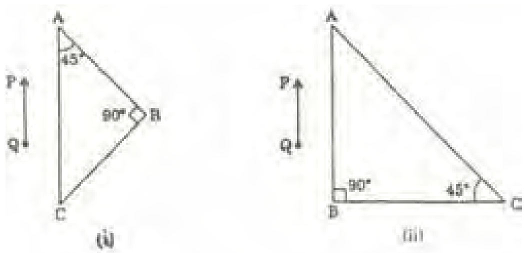
1. What is the geometrical shape of the wavefront when a plane wave passes through a convex lens?
2. What is total internal reflection? Under what condition does it take place.
3. A convex lens made up of a material of refractive index n_1, is immersed in a medium of refractive index n_2. Trace the path of a parallel beam of light passing through the lens when: (i) (i) $n_1 > n_2$, (ii) $n_1 = n_2$, & (iii) $n_1 < n_2$..Explain your answer.
4. A concave lens made of material of refractive index n_1 is kept in a medium of refractive index n_2. A parallel beam of light is incident on the lens. Complete the path of rays of light emerging from the concave lens if: (i) $n_1 > n_2$, (ii) $n_1 = n_2$, & (iii) $n_1 < n_2$.
5. Draw a ray diagram to show how an image is formed by a compound microscope. ?
6. A microscope is foucssed on a dot at the bottom of a beaker. Some oil is poured into the beaker to a height of 'y' cm & it is found necessary to raise microscope through a vertical distance of 'x' cm to bring the dot again into focus. Express refractive index of oil in terms of 'x' & 'y'.
7. How does the (i) magnifying power & (ii) resolving power of a telescope change on increasing the diameter of its objective? Give reasons for your answer.
8. How will magnifying power of a "refracting type astronomical telescope" be affecting on increasing for its eye piece: (i) the focal length, & (ii) the aperture. Justify your answer.
9. Draw a labelled ray diagram showing the formation of image of a distant object using an astronomical telescope in the 'normal adjustment position'
10. Draw a labelled ray diagram showing the formation of image of a distant object using an astronomical telescope in the near point adjustment.
11. Draw a ray diagram to illustrate image formation by a Cassegrain type reflecting telescope.
12. Explain with reason, how the resolving power of an astronomical telescope will change when (i) frequency of the incident light on objective lens is

increased (ii) the focal length of the objective lens is increased & (iii) aperture of the objective lens is halved.

13. Draw a graph to show variation of angle of deviation 'D' with that of angle of incidence 'i' for a monochromatic ray of light passing through a glass prism of reflecting angle 'A'.

3 MARKS

14. Derive lens/mirror formula in case of a convex/concave mirror.
15. Stating the assumptions and sign conventions, derive expression for lens maker's formula.
16. A right-angled crown glass prism with critical angle 41° is placed before an object, 'PQ' in two positions as shown in the figures (i) & (ii). Trace the paths of the rays from 'P' & 'Q' passing through the prisms in the two cases.



17. (a) Draw a labelled ray diagram to show the formation of an image by a compound microscope. Write the expression for its magnifying power.
18. (b) Define resolving power of a compound microscope. How does the resolving power of a compound microscope change, when (i) refractive index of the medium between the object and the objective lens increases and (ii) Wavelength of the radiation used is increased?
19. Define the term wave front? Using Huygen's construction draw a figure showing the propagation of a plane wave reflecting at the interface of the two media. Show that the angle of incidence is equal to the angle of reflection.
20. Define the term 'wavefront'. Draw the wavefront and corresponding rays in the case of a (i) diverging spherical wave (ii) plane wave. Using Huygen's construction of a wavefront, explain the refraction of a plane wavefront at a plane surface and hence deduce Snell's law.
21. What is meant by 'interference of light'? Write any two conditions necessary for obtaining well-defined and sustained interference pattern of light.

22. What is the effect on the interference fringes in a Young's double slit experiment due to each of the following operations? Give reason for your

answer: (i) Separation between two slits is increased & (ii) monochromatic source is replaced by a source of white light.

23. Draw the curve depicting variation of intensity in the interference pattern in Young's double slit experiment. State conditions for obtaining sustained interference pattern of light.

24. In a single slit diffraction pattern, how is angular width of central bright maximum changed when (i) the slit width is decreased, (ii) the distance between the slit and the screen is increased, & (iii) light of smaller wavelength is used? Justify your answers.

25. Why is diffraction of sound waves easier to observe than diffraction of light waves? What two main changes in diffraction pattern of a single slit will you observe when the monochromatic source of light is replaced by a source of white light?

26. In a single slit diffraction experiment, if the width of the slit is doubled, how does the (i) intensity of light and (ii) width of the central maximum change? Give reason for your answer.

27. What is wavefront? What is the geometrical shape of a wavefront emerging from a convex lens when point source is placed at the focus?

28. What is wavefront? Distinguish between a plane wavefront and a spherical wavefront. Explain with the help of a diagram, the refraction of a plane wavefront at a plane surface using Huygens's construction.

29. Using Huygens's principle show that for parallel beam incident on a reflecting surface the angle of reflection is equal to the angle of incidence.

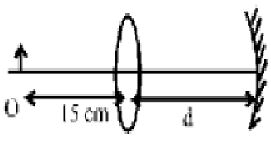
30. Distinguish between unpolarised and plane polarised light. An unpolarised light is incident on the boundary between two transparent media. State the condition when the reflected wave is totally plane polarised. Find out the expression for the angle of incidence in this case.

31. The following data was recorded for values of object distance and the corresponding values of image distance in the experiment on study of real image formation by a convex lens of power +5D. One of the observations is incorrect. Identify the observation and give reason for your choice.

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

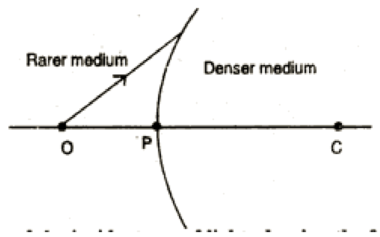
5 MARKS

32. (i) Derive the mirror formula which gives the relation between f, v and u. What is the corresponding formula for a thin lens? (ii) Calculate the distance d, so that a real image of an object at O, 15cm in front of a convex lens of



focal length 10cm be formed at the same point O. The radius of curvature of the mirror is 20cm. Will the image be inverted or erect?

33. A spherical surface of radius of curvature ‘R’ separates a rarer and a denser medium as shown in the figure.
Complete the path of the incident ray of light, showing the formation of real image. Hence derive the relation connecting object distance ‘u’, image distance ‘v’ radius of curvature ‘R’ and the refractive indices ‘n_1’ & ‘n_2’ of the media.



Briefly explain how the focal length of a convex lens changes with Increase in wavelength of incident light.
34. State the assumptions and sign conventions in deriving the Lens maker’s formula and also derive an expression for it.
35. Derive an expression for thin lens formula.
36. (a) In Young’s double slit experiment, deduce the conditions for: (i) constructive and (ii) destructive interference at a point on the screen. Draw a graph showing variation of the resultant intensity in the interference pattern against position ‘x’ on the screen.
(b) Compare and contrast the pattern which is seen with two coherently illuminated narrow slits in Young’s experiment with that seen for a coherently illuminated single slit producing diffraction.
37. State Huygens principle. Using the geometrical construction of secondary wavelets, explain the refraction of a plane wavefront incident at a plane surface. Hence verify Snell’s law of refraction. Illustrate with the help of diagrams the action of: (i) convex lens and (ii) concave mirror on a plane wavefront incident on it.
38. What is interference of light? Write two essential conditions for sustained interference pattern to be produced on the screen. Draw a graph showing the variation of intensity versus the position on the screen in Young’s experiment when (a) both the slits are opened and (b) one of the slit is closed. What is the effect on the interference pattern in Young’s double slit experiment when: (i) Screen is moved closer to the plane of slits? (ii)Separation between two slits is increased. Explain your answer in each case.

39. What are coherent sources of light? Two slits in Young's double slit experiment are illuminated by two different sodium lamps emitting light of the same wavelength. Why is no interference pattern observed?

(b) Obtain the condition for getting dark and bright fringes in Young's experiment. Hence write the expression for the fringe width.

(c) If S is the size of the source and its distance from the plane of the two slits, what should be the criterion for the interference fringes to be seen?

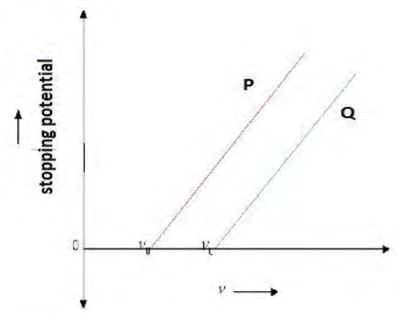
40. What do we understand by 'polarization of wave'? How does this phenomenon help us to decide whether a given wave is transverse or longitudinal in nature?

41. Light from an ordinary source (say, a sodium lamp) is passed through a Polaroid sheet 'P_1'. The transmitted light is then made to pass through a second Polaroid sheet P_2 which can be rotated so that the angle θ between the two Polaroid sheets varies from $0^\bullet$to $90^\bullet$. Show graphically the variation of intensity of light, transmitted by P_1& P_2 as a function of the angle θ. Take the incident beam intensity a I_0. Why does the light from a clear blue portion of the sky, show a rise and fall of intensity when viewed through a Polaroid which is rotated?

42. (a) Draw a ray diagram to show the refraction of light through a glass prism. Hence obtain the relation for the angle of deviation in terms of the angle of incidence, angle of emergence and the angle of the prism. (b) A right angled isosceles glass prism is made from glass of refractive index When a monochromatic yellow coloured light beam is incident on a given photosensitive surface, photoelectrons are not ejected, while the same surface gives photoelectrons when exposed to green coloured monochromatic beam. What will happen if the surface is exposed to: (i) red coloured, monochromatic beam of light? Justify your answer.

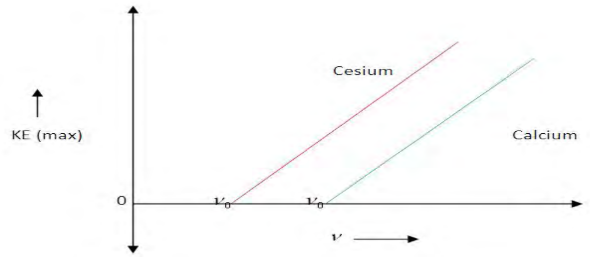
UNIT VII
DUAL NATURE OF MATTER
2 MARKS

1. When a monochromatic yellow coloured light beam is incident on a given photosensitive surface, photoelectrons are not ejected, while the same surface gives photoelectrons when exposed to green coloured monochromatic beam. What will happen if the surface is exposed to: (i) red coloured, monochromatic beam of light? Justify your answer.
2. What is meant by work function of a metal? How does the value of work function influence the kinetic energy of electrons liberated during photoelectric emission?
3. Define the terms: (i) work function, (ii) threshold frequency & (iii) stopping potential with reference of photoelectric effect.
4. The work function of lithium is 2.3 eV. What does it mean? What is the relation between the work function 'ω_o' and threshold wavelength 'λ_o' of a metal?
5. Red light, however bright, cannot cause emission of electrons from a clean zinc surface. But, even weak ultraviolet radiations can do so. Why?
6. An electron and a proton have same kinetic energy. Which of the two has a greater wavelength? Explain.
7. Define the term threshold frequency & work function in relation to photoelectric effect.
8. An electron and a proton are moving in the same direction and possess same kinetic energy. Find the ratio of de-Broglie wavelengths associated with these particles.
9. In the photoelectric effect experiment, the graph between the stopping potential 'V' and frequency 'v' of the incident radiation on two different metal plates P and Q are shown in the figure. (i) Which of the two metal plates, P & Q has greater value of work function? & (ii) What does the slope of the line depict?



3 MARKS

10. What is photoelectric effect? Write Einstein's photoelectric equation and use it to explain: (i) independence of maximum energy of emitted photoelectrons from the intensity of incident light. (ii) Existence of a threshold frequency for the emission of photoelectrons.
11. Draw the variation of maximum kinetic energy of emitted electrons with frequency of the incident radiation on a photosensitive surface. On the graph drawn, what do the following indicate: (i) slope of the graph & (ii) intercept on the energy axis.
12. Obtain Einstein's photoelectric equation. Explain how it enables us to understand the (i) linear dependence of the maximum kinetic energy of the emitted electrons, on the frequency of the incident radiation & (ii) existence of a threshold frequency for a given photo emitter.
13. Given below is the graph between frequency (v) of the incident light and maximum kinetic energy (E) of emitted photoelectrons. Find the values of: (i) threshold frequency and (ii) work function from the graph.



14. Sketch a graph between frequency of incident radiations and stopping potential for a given photosensitive materials. What information can be obtained from the value of intercept on the potential axis? A source of light of frequency greater that the threshold frequency is replaced at a distance of 1 m *from* the cathode of a photo cell. The stopping potential is found to be V. If the distance of the light source from the cathode is reduced, explain giving reason, what change you will observe in the (i) photoelectric current & (ii) stopping potential.

15. Explain the laws of photoelectric emission on the basis of Einstein's photoelectric equation. Write one feature of the photoelectric effect which cannot be explained on the basis of wave theory of light.
16. Draw graphs showing the variation of photoelectric current with anode potential of a photocell for (i) the same frequency but different intensities $I_1 > I_2 > I_3$ of incident radiation, & (ii) the same intensity but different frequencies $v_1 > v_2 > v_3$ of incident radiation. Explain why the saturation current is independent of the anode potential?

UNIT VIII
ATOMS & NUCLEI
2 MARKS

1. Define disintegration constant and mean life of a radioactive substance. Give the unit of each.
2. What is impact parameter? What is the value of impact parameter for a head on collision? The sequence of the stepwise decays of radioactive nucleus is:

   $$D \xrightarrow{\alpha} D1 \xrightarrow{\beta} D2 \xrightarrow{\alpha} D3 \xrightarrow{\alpha} D4.$$

   If the nucleon number and atomic number for D2 are respectively 176 & 71, what are the corresponding values for D and D4 nuclei? Justify your answer.
3. Draw a diagram to show the variation of binding energy per nucleon with mass number for different nuclei. Explain with the help of this plot the release of energy in the processes of nuclear fission and fusion?
4. The value of ground state energy of hydrogen atom is: -13.6 eV; (i) What does the negative sign signify? & (ii) How much energy is required to take an electron in this atom from the ground state to the first excited state?
5. Give one point of difference between 'nuclear fission' & 'nuclear fusion'. Will neutron to proto ratio increase or decrease in a nucleus when: (i) an electron, (ii) a positron is emitted?
6. Sketch the graph showing the variation of potential energy of a pair of nucleons as a function of their separation. Write three characteristic properties of nuclear force which distinguish it from the electrostatic force.
7. State two characteristics of nuclear force. Why does the binding energy per nucleon decrease with increase in mass number for heavy nuclei like ^{235}U?
8. State the condition for controlled chain reaction to occur in a nuclear reactor. Heavy water is often used as a moderator in thermal nuclear reactors. Give reason.
9. Define activity of a substance. State its S.I unit. Derive an expression for activity of a substance.

10. Define average or mean value of a radioactive substance, and derive an expression for it.

3 MARKS

11. State the basic postulates of Bohr's atomic model & derive an expression for the energy of an electron in any orbit of hydrogen atom.
12. Derive an expression for the radius of stationary orbit. Prove that the various stationary orbits are not equally spaced.
13. Derive mathematical expressions for: (i) kinetic energy, & (ii) potential energy of an electron revolving in an orbit of radius 'r'; how does the potential energy change with increase in principal quantum number (n) for the electron and why?
14. Define the decay constant for a radioactive sample. Which of the following radiations α, β, & λ rays are: (i) similar to X-rays? (ii) easily absorbed by matter? & (iii) similar in nature to cathode rays?
15. Define the terms: half life period and decay constant of a radioactive sample. Derive the relation between these terms.
16. In Rutherford's scattering experiment, mention two important conclusions which can be drawn by studying the scattering of α particles by an atom. Draw the schematic arrangement of Geiger and Marsden experiment showing the scattering of α particle by a thin foil of gold. How does one get the information regarding the size of the nucleus in this experiment?
17. Sketch the energy level diagram for hydrogen atom. Mark the transitions corresponding to Lyman and Balmer series.
18. Prove that the instantaneous rate of change of the activity of a radioactive substance is inversely proportional to the square of its half life.

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.

3 MARKS

5. What is rectification? How can a diode valve be used as half wave rectifier and full wave rectifier?

6. Explain how the depletion layer and the barrier potential are formed in a p-n junction diode.

7. 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.

8. 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

9. 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.

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10. Draw the energy bands of p-type and n-type semiconductors. Explain with a circuit diagram the working of a full wave rectifier.

OBJECTIVE / MCQ TYPE QUESTIONS FOR CLASS XII

ELECTRO STATICS

1. A certain charge Q is divided into two parts q and q'. Later on, the charges are placed at a certain distance. If the force of attraction between two charges is maximum, then:

   A) q/q' =2 B) q/q' =1 C) q/q' =4 D) q/q' =3

2. A proton is placed in a uniform electric field directed along the position X-axis. In which direction will it tend to move?

   A) Along Yaxis B) along Z-axis C) along X-axis d) None of the above

3. Two point charges having equal charge are separated by 1m distance experience a force of 8N. What will be the force if they are held in water at the same distance?

   (Given $k_{water} = 80$)

   A) 1/5 B) 1/10 C) 1/20 D) 1/15

4. A dipole, of dipole moment p is present in a uniform electric field E. The value of angle between p and E for which the dipole experiences minimum torque is

   A) 90° B) 60° C) 120° D) 0°

5. What does $q_1 + q_2 = 0$ signify in electrostatics?

   A) q_1 & q_2 are equal and opposite.

   B) q_1 & q_2 are equal

   C) $q_1 > q_2$

   D) $q_1 < q_2$

6. A dipole, with its charge**, -q** and **+q**, located at the point (0,-b, 0) and (0,+b,0), is present in a uniform electric field **E**. The equipotential surfaces of the field are planes parallel to the Y-Z planes. What is the direction of the electric field E?

   A) Along Y-axis B) along Z-axis C) along X-axis d) None of the above

7. Point out right or wrong for the following statement:

a) The mutual force between two charges is not affected by the presence of other charges.

b) The potential, due to a dipole, at any point on its axial line, is zero.

A) (a) is wrong, (b) is wrongright B) both are wrong

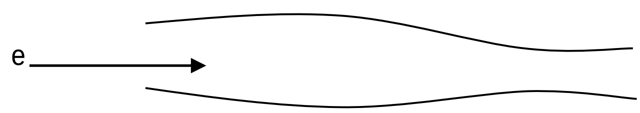
C) both are right D) (a) is right, (b) is wrong

8. In which orientation a dipole placed in a uniform electric field is in unstable equilibrium?

A) angle between p and E must be 0^0 B) angle between p and E must be 90^0

C) angle between p and E must be 60^0 D) angle between p and E must be 120^0

9. An electron moves along a metal tube with variable cross-section, as shown in figure. How will the velocity change when it approaches the neck of the tube?



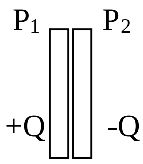
A) Electron gets deaccelerated towards the neck

B) Electron gets accelerated towards the neck

C) Electron moves with steady speed towards the neck

D) Electron will not move

10. Figure shows two large metal plates, P_1 and P_2, tightly held against each other and placed between two equal and unlike point charges perpendicular to the line joining them.



What will happen to the plates when they are released?

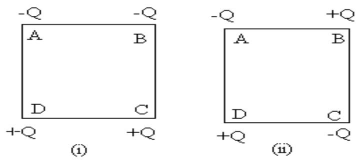
A) They tend to move a part slightly due to polarisation of charges in them.

B) They tend to move towards each other

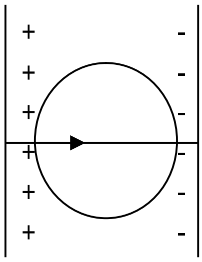
C) They do not move

D) Non of the above

11. Define dipole moment of an electric dipole.
12. Why must electrostatic field be normal to the surface at every point of a charged conductor?
13. Draw a plot showing variation of
    a) Electric field E and
    b) Electric potential V with distance r due to a point charge Q.
14. Plot a graph showing the variation of Coulomb's force (**F**) versus **1/r^2** where **r** is the distance between the two charges of each pair of charge(1 μC,2 μC) and (1 μC,-3 μC).
15. A spherical conducting shell of inner radius **R_1** and outer radius **R_2** has a charge **Q**. A charge **q** is placed at the centre of the shell.
    i) What is the surface charge density on the a) Inner surface b) Outer surface of the shell.
    ii) Write the expression for the electric field at a point $x > R_2$ from the centre of the shell.
16. Two charges +Q and –Q are kept at ($-x_2$, 0) and (x_1, 0) respectively in the X-Y plane. Find the magnitude and direction of the net electric field at the origin (0,0).
17. Show that the electric field at the surface of charged conductor is given by $E = \frac{\sigma}{\epsilon_0}\hat{n}$, where $\boldsymbol{\sigma}$ is the surface charge density and $\hat{\boldsymbol{n}}$ is a unit vector normal to the surface of the conductor.
18. Four point charges are placed at the four corners of a square in the two ways (i) and (ii) as shown below. Will the Electric field at the centre of the square, be the same or different in the two configurations and why?

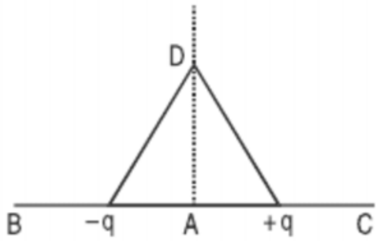


19. A metallic sphere placed between two charged metallic plates. A student draws the lines of force as shown in figure. Is he correct?

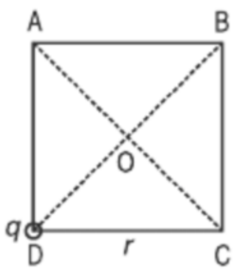


20. Two charged spherical conductors, each of radiuses R, are distance **d** apart such that **d** is slightly greater than 2R. They carry charges +q and -q. Will the force of attraction between them be exactly $\frac{q^2}{4\pi\epsilon_0 d^2}$?

21. Two point charges +q and –q are placed 2l apart, as shown in figure. Give the direction of electric field at A, B, C and D.



22. What is the electric field at O in the figure? ABCD is a square of side r.



23. Suppose two spheres A and B of charge $6.5x10^{-7}$C each are separated by 50 cm. A third uncharged sphere C of same size is brought in contact with first charge, then 2nd charge and finally removed. Find the new force of repulsion between the charges A and B.

24. In an electric field an electron is kept freely. If the electron is replaced by a proton, what will be the relationship between the forces experienced by them?
25. Define electric field intensity. What is its SI unit?
26. How does the force between two point charges change, if the dielectric constant of the medium in which they are kept, increases?
27. Define electric dipole moment. Write its SI unit.
28. 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.
29. When does an electric dipole placed in a non-uniform electric field experiences a zero torque but non-zero force?
30. Why direction of an electric field is taken outward (away) for a positive charge and inward (towards) for a negative charge?
31. A small test charge is released at rest at a point in an electrostatic field configuration. Will it travel along the line of force passing through that point?
32. Can a body have a charge of 0.8×10^{-19} C? Justify your answer.
33. The dielectric constant of water is 80. What is its permittivity?
34. What is a continuous charge distribution?
35. Define dielectric constant of a medium in terms of force between electric charges.
36. The dimensions of an atom are of the order of an Angstrom. Thus, there must be large electric fields between the protons and electrons. Why, then is the electrostatic field inside a conductor is zero?
37. Two insulated charged copper spheres A and B of identical size have charges q_A & q_B respectively. A third sphere C of the same size but uncharged is brought in contact with the first and then in contact with the second and finally removed from both. What are the new charges on A and B?
38. Why should electrostatic field be zero inside a conductor?

39. Calculate the work done to dissociate the system of three charges ('q' each) placed on the vertices of equilateral triangle.

40. The electric field E due to a point charge at any point near it is defined as E = $\lim_{q\to 0}(\frac{F}{q})$ where 'q' is the test charge and F is the force acting on it. What is the physical significance of $Lim_{q\to 0}$ in this expression?

41. SI unit of electric flux (   )

a) Nm^2C^{-1} b) $N^{-1}\,m^2\,C$ c) Nm^2C^2 d) None of the above

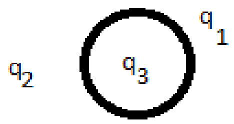
42. SI unit of electric flux density (   )

a) NC^{-1} b) NC   c) $N^{-1}\,C$ d) None of the above

43. For a medium of absolute permittivity ϵ or dielectric constant K , then Gauss theorem can be expressed as _____

a) $\oint E.ds = \frac{q}{t} = \frac{q}{k\epsilon_0}$ b) $k.\frac{q}{\epsilon_o}$ c) $\frac{k\epsilon_0}{q}$ d) $\frac{q}{KE}$

44. q_1, q_2 , q_3 are charges and Gaussian surface is spherical shape ; shown in figure. Find the flux?



a) $\frac{q_1}{\epsilon_0}$ b) $\frac{q_2}{\epsilon_0}$ c) $\frac{q_3}{\epsilon_0}$ d) $\frac{\epsilon_0}{q_3}$

45. A square shape box encloses an electric dipole and of length 10cm . What is the total electric flux through the box?

a) $2NC^{-1}m^2$ b) zero   c) $10\,NC^{-1}m^2$ d) None of the above

46. A charge q is placed at the center of a cube side l. What is the electric flux passing through each face of the cube?

a) $\frac{6q}{\epsilon_0}$ b) $\frac{q}{\epsilon_0}$ c) $\frac{8q}{\epsilon_0}$ d) $\frac{q}{6\epsilon_0}$

47. How the electric field E , depends upon the distance (r) due to an infinitely long thin straight charged wire?

a) $E \propto r$ b) $E \propto \frac{1}{r}$ c) $E \propto \frac{1}{r^2}$ d) $E \propto r^2$

48. How the electric field E depends upon the distance r due to uniform charge distributed on a thin infinite plane sheet is

a) $E \propto r^2$ b) $E \propto r$ c) $E \propto r^0$ d) $E \propto r^3$

49. What is the electric field inside a uniformly charged thin spherical shell?

a) E = 0 b) $E = \frac{q}{4\pi\epsilon_{0\,r}}$ c) $E = \frac{q}{4\pi\epsilon_{0\,R}}$ d) None of the above

50. Total electric flux coming out of a unit positive charge put in air is ?

a) ε_0 b) ${\varepsilon_0}^{-1}$ c) $4\pi\varepsilon_0$ d) $\frac{\epsilon_0}{2}$

51. The surface densities on the surfaces of two charged spherical conductors of radii R_1 and R_2 are equal. The ratio of electric field intensities on the surfaces are

a) $\frac{{R_2}^2}{{R_1}^2}$ b) $\frac{{R_1}^2}{{R_2}^2}$ c) $\frac{R_1}{R_2}$ d) 1:1

52. Two charges of magnitudes -2q and q are located at points (a,o) (2a,o) respectively. What is the electric flux due to these charges through a sphere of radius 3a with its centre at the origin?

a) $-\frac{q}{\epsilon_0}$ b) $\frac{3q}{\epsilon_0}$ c) zero d) None of the above

53. An infinite line charge produces a field of $9\times10^4 Nc^{-1}$ at a distance of 2 cm. Calculate the linear charge density?

a) $10^{-7}cm^{-1}$ b) $10^{-9}cm^{-1}$ c) $10^{-12}cm^{-1}$ d) None of the above

54. Two large thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs and of magnitude $17\times10^{-22}cm^{-2}$. What is E in between the plates?

a) $1.9\times10^{-10}Nc^{-1}$ b) $2.9\times10^{-10}Nc^{-1}$ c) $19\times10^{-10}Nc^{-1}$ d) None of the above

55. If the electric field is given by $\bar{E} = 8\mathbf{i}+4\mathbf{j}+3\mathbf{k}\,Nc^{-1}$. Find the electric flux through a surface of area 100 m^2 lying in the X-Y plane.

a) 300 Nm^2C^{-1} b)320 Nm^2C^{-1} c) 400 Nm^2C^{-1} d) None of the above

56. A spherical Gaussian surface encloses a charge of 8.85×10^{-8}C. How would the flux change, if the radius of the Gaussian surface is doubled.

a) Doubled b) No change c) Halved d) None of the above

57. A spherical shell of metal has a radius of 0.25 m and carries a charge of $0.2\mu C$. Find the field intensity at a point 3m from the centre of the shell?

a) 300 NC^{-1} b) 200 NC c) 100 NC^{-1} d) 50 NC^{-1}

58. The charge q is kept in the hemisphere. What is the flux through this surface.?

a) $\frac{q}{\epsilon_0}$ b) $\frac{q}{2\epsilon_0}$ c) $\frac{2q}{\epsilon_0}$ d) None of the above

59. Three concentric spherical shells of radii R and 2R are given charges $q_{1,}$ and q_2 respectively. The surface charge densities of the outer surfaces are equal, then the ratio of $q_{1,} : q_2$ is

a) 1:2 b) 2:1 c) 1:4 d) 4:1

60. 5000 lines of force enter a certain volume of space and 3000 line emerge from it . What is the total charge in Coulomb within this volume?

a) $1.88\times10^{-8}C$ b) 1.77×10^{-8}C c) $7.11\times10^{-8}C$ d) None of the above

61. A positive charge of 17.7 μC is placed at the centre of a hollow sphere of radius 0.5m. Calculate the flux density through the surface of the sphere ?

a) $6.4\times10^5 NC^{-1}$ b) $4.6\times10^{-5} NC^{-1}$ c) $2.4\times10^5 NC^{-1}$ d) None of the above

62. A circular plane sheet of radius 10 cm is placed in a uniform electric field of $5 \times 10^5\ NC^{-1}$ making an angle of 60° with the field. Calculate electric flux through the sheet?

a) $1.3\times10^4 Nm^2C^{-1}$ b) $3.16 \times 10^4 Nm^2C^{-1}$ c) $1.36 \times 10^4 Nm^2C^{-1}$

d) None of the above

63. A charge q is placed at the the centre of a cube of side (l). What is the electric flux passing through two opposite faces of the cube?

a) $\frac{q}{2\epsilon_0}$ b) $\frac{q}{\epsilon_0}$ c) $\frac{q}{3\epsilon_0}$ d) None of the above

64. Which of the following is discontinuous across a charged conducting surface?

a) Electric potential b) Electric field intensity

c) both electric potential and field intensity d) None of the above

65. The Gaussian surface for calculating the electric field due to a charge distribution is

a) any closed surface around the charge distribution

b) any surface near the charge distribution

c) spherical surface

d) a symmetrical closed surface at every point of which electric field has a single fixed value

66. Two thick parallel sheets have uniform surface densities of charge +σ and -σ. Electric field in the space between the two sheets would be

a) σ/ϵ_o b) $2\sigma/\epsilon_o$ c) $3\sigma/\epsilon_o$ d) none of the above

67. Electric flux at a point in electric field is

a) positive b) negative c) zero d) none of the above

68. Electric flux over the surface in an electric field may be

a) positive b) negative c) zero d) positive, negative, zero

69. In a region of space having a uniform electric field E, a hemispherical bowl of radius r is placed. The electric flux Φ through the bowl is

a) $2\pi rE$ b) $4\pi r^2 E$ c) $\pi r^2 E$ d) $2 \pi r^2 E$

70. A cylinder of radius R and length l is placed in a uniform electric field E parallel to the axis of the cylinder. The total flux over the curved surface of cylinder is

a) zero b) $\pi R^2 E$ c) $2 \pi R^2 E$ d) none of the above

71. The SI unit of closed surface integral of electric field is

a) V-m b) $V\text{-}m^{-1}$ c) $NC^{-1}m^2$ d) none of the above

72. Two thin infinite parallel sheets have uniform surface densities of charge +σ and -σ. Electric field in the space outside the sheets is

a) σ/ϵ_0 b) $2\sigma/\epsilon_0$ c) $3\sigma/\epsilon_0$ d) zero

73. Inward electric flux through a closed surface is

a) $\Phi = \oint E.ds = -q/\epsilon o$ b) $\Phi = \oint E.ds = q/\epsilon o$ c) $\Phi = \oint E.ds = 2q/\epsilon o$
d) none of the above

74. If q is the charge per unit area on the surface of spherical conductor, then the electric field intensity at a point on the surface is
a) $q/\epsilon o$ normal to the surface b) $q/2\epsilon o$ normal to the surface
c) $q/\epsilon o$ tangential to the surface d) $q/2\epsilon o$ tangential to the surface
75. Eight dipoles of charges of magnitude (e) are placed inside a cube, the total electric flux coming out of the cube will be
a) $8e/\epsilon o$ b) $e/8\epsilon o$ c) zero d) $e/\epsilon o$
76. The electric field at a distance 3R/2 from the centre of the charged conducting spherical shell of radius R is E. The electric field at a distance R/2 from the centre of the sphere is
a) zero b) E c) E/2 d) E/3
77. A square surface of side (l)m in the plane of the paper. A uniform electric field E is also in the plane of the paper but limited to half of the square surface. Electric flux with the surface is
a) $El^2/2$ b) $El^2/2\epsilon o$ c) zero d) $2\epsilon o E^2 l$
78. For a given surface the Gauss's law is stated as $\oint \mathbf{E.ds=0}$ from this we conclude that
a) E is necessarily zero on the surface
b) E is perpendicular to the surface at every point
c) the total flux through the surface is zero
d) none of the above
79. The electric field in a certain region of space is $(5\mathbf{i} + 4\mathbf{j} - 4\mathbf{k}) \times 10^5\ NC^{-1}$. Calculate the electric flux due to this field over an area of $(2\mathbf{i} - \mathbf{j}) \times 10^{-2}\ m^2$
a) $6 \times 10^3\ Nm^2C^{-1}$ b) $8 \times 10^3\ Nm^2C^{-1}$ c) $10 \times 10^5\ N\ m^2C^{-1}$ d) none of the above
80. The net flux through a closed surface due to a charge lying outside the closed surface is
a) $q/\epsilon o$ b) $q/2\epsilon o$ c) zero d) none of the above

Electric Potential and Capacitance

(1) What is nature of electrostatic field?
(2)Write equation for difference of potential energy a(ΔU)charge in an electrostatic field. How is it defined?
(2) What is equation for potential energy of a charge in an Δ electro static field? How is it defined?
(3) Define the term electrostatic potential in an electric field.
(4) Define the term potential difference in an electrostatic field or electric circuit.

(5) Is electrostatic potential & potential difference (V△V) a vector or scalar quantity? Explain. (5)What is the S.I. unit of electrostatic potential & potential difference?

(6) Define the term volt.

(7) Write the dimensional formula of potential (V), potential difference (V) & volt (V).

(8) Write the equation for potential due to a point charge Q or q at a distance r from it.

(9) Mentions the natures of potential produced by positive & negative charges and also explain it.

(10) State & the principle of superposition of electric potentials.

(11) Write an equation for electric potential due to an electric dipole.

(12) Write an equation for potential due to a sphere of charge or spherical distribution of charge.

(13) Write equations for electric potential due a shell of charge or hollow sphere of charge.

(14) Define the term equipotential surface.

(15) What is the amount of work to be done to transfer a unit charge by unit distance on an equipotential surface in an electrostatic field? Explain your answer.

(16) What is the amount of work to be done to transfer a charge Q Or q by a distance x or d on an equipotential surface. Explain your answer.

(17) Write an equation to show relation between electric field & potential.

(18) What is physical relation between equipotential surface & electric field.

(19) Write equation for potential energy of a charge Q or q at a potential V in an electrostatic field.

(20) Mention equation for energy gained by a charge Q or q by a potential difference V or dv in an external electric field.

(21) Write the equation for potential energy of two charges in an external electric field.

(22) Mention an equation for potential energy of an electric dipole in an external electric field of strength (intensity) E.

(23) For which orientation or inclination with an electric field an electric dipole has stable equilibrium.

(24) For which orientation or inclination with an electric field an electric dipole has unstable equilibrium.

(25) What is the potential of the earth?

(26) Why the potential of earth is always taken as zero?

(27) What is the effect of a dielectric on electrostatic potential produced by a charge?

(28) Express eV in terms of joules (or) Calculate one electron volt of energy.

(29) What is name given to the change in potential energy of a unit charge between two points In an electric field ?

(30) Express dielectric constant(DEC) of a medium in terms of potentials developed by a charge.

MCQS

(31) Two points P and Q are maintained at the potentials of 10 V and – 4 V, respectively. The work done in moving 100 electrons from P to Q is [ ]

a) 2.24×10^{-16} j b) -2.24×10^{-16} j

c) 2.0×10^{-16} j d) 1.24×10^{-16} j

(32) Energy can be expressed in terms of? [ ]

a) volt b) electron

c) Farad d) electron volt

(33) The work done in moving a positive charge from one point to another in an Equipotential surface is [ ]

a) Positive b) negative

c) Maximum d) zero.

(34) The rate of change of potential with respect to distance is called as? [ ]

a) Potential difference b) capacitance

c) Potential gradient d) none of these

(35) Which of the following cannot be the units of electric intensity? [ ]

a) V/m b) J/C

c) N/m d) J/Cm

FILL IN BLANKS

(36) Dielectric constant of mica is_____________

(37) Shape of equipotential surface for a point charge is _____________________

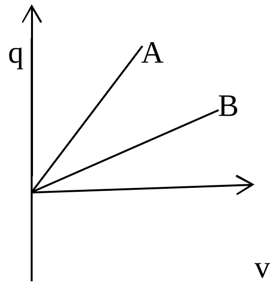
(38) Shape of equipotential surface for a uniform electric field is____________________

(39) Equipotential surfaces ________________ intersect each other.

(40) For increasing field in a direction the distance between equipotential surfaces gradually______________

41. The maximum electric field that a dielectric medium of a capacitor can withstand without break down (of its insulating property) is called its
42. A parallel plate capacitor has circular plates of radius 8 cm and plate separation 1mm. What will be the charge on the plates if a potential difference of 100V is applied?
43. A parallel plate air capacitor has a capacitance 18μF. If the distance between the plates is tripled and a dielectric medium is introduced, the capacitance becomes 72μF. The dielectric constant of the medium is?
44. The capacitance of a spherical conductor is 1μF. Its radius is?
45. Capacitance between point A and B is when two capacitors of 2 μF are connected in series and a capacitor of 3 μF in parallel to them?
46. Distinguish between a dielectric and a conductor?
47. Define the dielectric constant of a medium. What is its unit?

48. The given graph shows the variation of charge q vs. potential difference V for two capacitors C_1 and C_2. Both the capacitors have same plate separation but plate area of C_2 is greater than that of C_1. Which line (A or B) corresponds to C_1 and why?



49. If the difference between the radii of two spheres of a spherical conductor is increased, state whether the capacitance will increase or decrease?
50. A metal plate is introduced between the plates of a charged parallel plate capacitor. What is its effect on the capacitance of the capacitor?
51. A spherical shell of radius b with charge Q is expanded to a radius a. Find the work done by the electric forces in the process?
52. Distinguish between polar and non-polar dielectrics?
53. A sensitive instrument is to be shifted from the strong electrostatic field in its environment. Suggest a possible way?
54. The safest way to protect you from lightning is to be inside a car. Comment
55. Can the potential function have a maximum or minimum in free save?
56. Why does the electric conductivity of the earth's atmosphere increase with altitude?
57. Guess a possible reason, why water has a much greater dielectric constant (=80) than mica (=6)?
58. Determine the work done in moving a test charge q through the distance 1cm along the equatorial axis of an electric dipole.
59. Why there is no work done in moving a charge from one point to another on an equipotential surface?
60. Assume a charge starting at rest on an equipotential surface is moved off that surface and then is eventually returned to the same surface of rest after a round trip. How much work did it take to do this? Explain
61. Do electrons tend to go the regions of high potential or low potential?

62. A proton is released at rest in a uniform electric field. Does the protons electric potential energy increase or decrease?

    Does the proton move towards a location with higher or lower electric potential?

63. What is the net charge on a charged capacitor?

64. Do circular metal plates, each of radius 10cm, are parallel to each other at a distance 1mm. what kind of capacitor do they make ? mention one application of this capacitor

65. A metal plate is introduced between the plates of a charged parallel plate capacitor. What is its effect on the capacitance of the capacitor?

66. The potential to which a conductor is raised, depends on
    a) Amount of charge
    b) Geometry and size of the conductor
    c) Both (a) and (b)
    d) Only on (a)

67. A parallel plate air capacitor is charged and then isolated. When a dielectric material is inserted between the plates of the capacitor, then which of the following does not change
    a) Electric field between the plates
    b) Potential difference across the plates
    c) Charge on the plates
    d) Energy stored in the capacitor

68. An air filled parallel plate condenser has a capacity of 2pF. The separation of the plates is doubled and the interspace between the plates if filled with wax. If the capacity is increased to 6pF, the dielectric constant of wax is
    a) 2
    b) 3
    c) 4
    d) 6

69. A parallel plate air capacitor has a capacitance C. when it is half filled with dielectric of dielectric constant 5, the % increase in the capacitance will be
    a) 400%

b) 66.6%

c) 33.3%

d) 200%

70. Two capacitor of capacitance C are connected in series. If one of them is filled with dielectric substance k, what is the effective capacitance?

a) kC/(1+k)

b) C(k+1)

c) 2kC/1+k

d) None of these

71. A capacitor of capacitance 1μF is filled with two dielectric of dielectric constant 4 and 6. What is the new capacitance?

a) 10 μF

b) 5 μF

c) 4 μF

d) 7 μF

72. A 10 μF capacitor is charged to 500 V and then its plates are joined together through a resistance of 10 ohm. The heat produced in the resistance is

a) 500J

b) 250J

c) 125J

d) 1.25J

73. If there are n capacitors in parallel connected to V volt source, then the energy stored is

a) CV

b) $1/2 \times n \times C \times V^2$

c) CV^2

d) $1/2n \times CV^2$

74. A capacitor is charged by connecting a battery across its plates. It stores energy U. now the battery is disconnected and another identical capacitor is connected across it, then the energy stored by both capacitors of the system will be

a) U

b) U/2

c) 2U
d) 3/2U

75. A capacitor of capacitance C has charge Q and stored energy is W. if the charge is increased to 2Q, the stored energy will be
a) W/4
b) W/2
c) 2W
d) 4W

76. If the charge of 10 μC and -2 μC are given to two plates of a capacitor which are connected across a battery of 12V, find the capacitance of the capacitor
a) 0.33 μF
b) 0.5 μF
c) 0.41 μF
d) 0.66 μF

77. An air capacitor is charged with an amount of charge q and dipped into an oil tank. If the oil is pumped out, the electric fields between the plates will
a) Increase
b) Decrease
c) Remains the same
d) Become zero

78. Parallel plate capacitor is charged. If the plates are pulled a part,
a) The capacitance increases
b) The potential difference increases
c) Total charge increases
d) The charge and potential difference remains the same

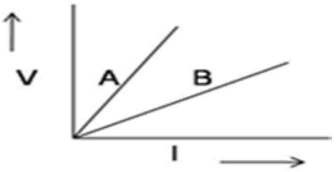
79. The capacity of a spherical condenser is 1 μF. if the spacing between the two spheres is 1mm, the radius of outer sphere is
a) 3cm
b) 6cm
c) 3m
d) 6m

80. What do you mean by polarization of dielectric?

CURRENT ELECTRICITY

1. What is the SI unit of resistivity?

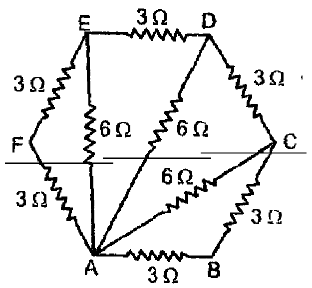
2. V and I graph for the parallel and series combination of two resistors is as shown. Which graph does indicate the parallel combination?



3. If the electron drift speed is so small and electron charge is so

   Small how can we still obtain a large amount of current in a conductor?

4. Which material preferred to use in electric heater and why?
5. Name two applications of Wheatstone bridge.
6. Sixr esistors of 3 each are connected along the side sofa hexagon and three resistor sof6 each are connected along AC, AD, and A Eass how ninthe figiure. The equivalent desistance between A and B is equal to:



7. Does the resistance change during bending or reorienting the wire? Why?
8. Write the principle on which a metre bridge works?
9. Define current density. State whether it is a scalar or vector?
10. What happens to the drift velocity of electrons with rise of temperature?
11. Define mobility? Write its SI Unit.
12. A cell of emf 2 V and internal résistance 0.1 Ω is connected to a 3.9 Ω external resistance. What will be the current in circuit?
13. A cell of emf 2 V and internal résistance 0.1 Ω is connected to a 3.9 Ω external resistance. What will be the p.d. across the terminals of the cell?
14. Calculate the resistivity of a material of a wire 1 m long, 0.4 mm in diameter and having a resistance of 2 ohm.
15. A cell of emf '*E*' and internal resistance '*r*' is connected across a variable resistor '*R*'. Plot a graph showing the variation of terminal potential '*V*' with resistance *R*. Predict from the graph the condition under which '*V*' becomes equal to '*E*'.

16. A wire of 15 W resistances is gradually stretched to double its original length. It is then cut into two equal parts. These parts are then connected in parallel across a 3 volt battery. Find the current drawn from the battery.
17. Out of the two bulbs marked 25W and 100W, which one has higher resistance?
18. A silver wire has a resistance of 2.1 Ω at 27.5 ^{0}C, and a resistance of 2.7 Ω at 100 ^{0}C. Determine the temperature coefficient of resistivity of silver.

19. a) Three resistors 2 Ω, 4 Ω and 5 Ω are combined in parallel. What is the total resistance of the combination?

    (b) If the combination is connected to a battery of emf 20 V and negligible internal resistance and the total current drawn from the battery.

20. A Voltage of 30V is applied across a carbon resistor with first second and third rings of blue, black and yellow colours respectively. Calculate the value of current in mA, through the resistor.

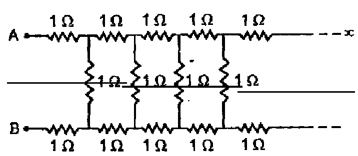
MCQ ON CURRENT ELECTRICITY

21. Which is the dimensional formula for resistance from the given below? (A)$M^1L^2T^3A^2$(B)$M^{-1}L^2T^3A^2$ (C)$M^1L^3T^3A^2$ (D)$M^1L^3T^3A^2$

22. Which is the dimensional formula for resistance from the given below? (A)$M^1L^2T^3A^{-2}$ (B)$M^{-1}L^2T$ (C)$M^1L^3T^3A^2$ (D)$M^1L^3T^3A^2$
23. Resistivity of material of a conducting wire is $4X10^{-8}$m volume of the wire is $4m^3$ and its resistance is 4 times there foreits length will be.

    (A)500m (B)5000m (C)20,000m (D) $4x10^{-5}$m

24. The given figure shows an infinite ladder network of resistances. The equivalent resistance between points A and B is.



    (A) Infinite (B) 3.73
    (C) 2.73 (D) $\frac{2}{3}$
25. A carbon resistor has a set of coaxial colour in the order brown,violet, brown and silver. The value of resistance(in ohms) is.
    (A) (27x10) ± 5% (B) (27x10) ± 10%
    (C) (17x10) ± 5% (D) (17x10) ± 10%

26. Across a wire of length l and thickness d, ap. D of Visapplied. If the p.d. is doubled the drift velocity becomes....

(A) Becomes double (B) becomes half

(C) Can not change (D) becomes Zero

27. The masses of three wires of copper are in the ratio of 1:3:5 and their lengths are in the ratio of 5:3:1.The ratio of their electrical resistanceis:

(A)1:1:1 (B)1:3:5 (C)5:3:1 (D)125:15:1

28. Two electric bulbs marked 25W-220V and 100W-220V are connected in series to a 440v supply which of the bulbs will fuse?

(A) 100W (B) 25W (C) None of this (D) Both

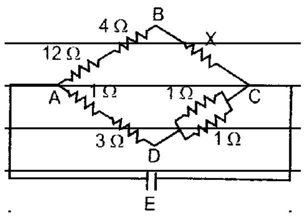
29. A parallel combination of three resistors takes a current of 7.5A from a 30V supply, If the two resistors are 10 Ωand 12 Ω find which is the third one?

(A)4Ω (B)15Ω (C)12Ω (D) 22Ω

30. How many dry cells, each of emf 1.5V and internal resistance 0.5 Ω, much be joined in series with a resistor of 20Ω to give a current of 0.6 A in the circuit?

(A) 2 (B) 8 (C) 10 (D) 12

31. In the arrangement of resistances show ninthe figure, the potential difference between B and D will be zero when the unknown resistance X is



(A) 4Ω (B) 2Ω

(C) 3Ω (D) 6Ω

32. Two electric bulbs whose resistances are in the ratio of 1:2 are connected in parallel to aconstant voltage source the power dissipated in them have the ratio.

(A) 1:2 (B) 1:1 (C) 2:1 (D) 1:4

33. If the above two bulbs are connected in series, the power dissipated in them

have the ratio:

(A)1:2 (B)1:1 (C)2:1 (D)1:4

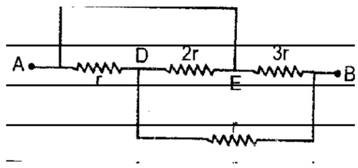
34. An electric kettle has two coils. When one of them is switched on, the water in the kettle boils in 6 minutes. When the other coilis switched on, the water boils in 3 minutes. If the two coils are connected in series the time taken to boil water in the kettle is:

(A) 3minutes (B) 6minutes (C) 2minutes (D) 9minutes

35. A wire of length L is drawn such that its diameter is reduced to half of its original diameter. If the resistance of the wire were10Ω, its new resistance would be.

A) 40Ω (B) 60Ω (C) 120Ω (D) 160Ω

36. What is the equivalent resistance across the terminals A and B?



(A) $\frac{15r}{7}$ (B) $\frac{7r}{15}$

(C) 15r/14 (D) 8r/15

37. Two heater wires of equal length are first connected in series and then in parallel. The ratio of heat produced in the two cases is....

(A) 2:1 (B)1:2 (C) 4:1 (D) 1:4

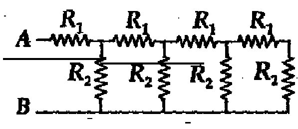
38. The potential difference between the terminals of a battery is 10 V and internal resistance1Ω drops to 8Vwhen connected across an external resistor find the resistance of the external resistor.

(A) 40Ω (B) 0.4Ω (C) 4MΩ (D) 4Ω

39. The resistance of a copper coil is 4. 64Ω at40°C and 5.6Ω at 100°C. Its resistance at 0°C will be

(A) 5Ω (B) 4Ω (C) 3Ω (D) 2Ω

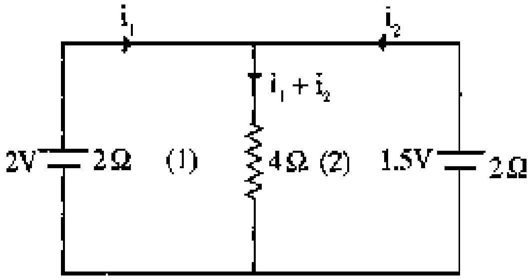
40. A circuit with an infinite no of resistance is show nin fig. the resultant resistance between A and B, when R_1 1Ω and R_2 2Ω will be



(A) 4Ω (B) 1Ω

(C) 2Ω (D) 3Ω

41. The currents i_1, i_2 in the given circuit are



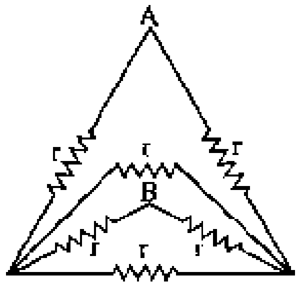
1) 0.5A, 0.5A 2) 0.4A, 0.6A

3) 0.3A, 0.05A 4) 0.06A, 0.6A

42. Hundred Cells each of emf 5V and internal resistance 1 ohm are to be arranged so as to produce a maximum current in a 25 ohm resistance. Each row contains equal number of cells. The number of rows should be

1) 2 2) 4 3) 5 4) 10

43. If six conductors each of resistance 'r' are connected as shown in the figure, the equivalent resistance between A and B is



1) r/3 2) r/4 3) r/ 6 4) r

Metre Bridge and Potentiometer Questions

1. When 2 resistances P and Q are kept in the left and right gaps of a meter bridge, the null point is obtained at 60 cm. If P is shunted by a resistance equal to half of its value, the shift in null point is

1) 10 cm to the left 2) 10cm to the right

3) 26.7 cm to the left 4) 26.7 cm to right

2. In a meter bridge, the left and right gaps are closed by resistances 2 ohm and 3 ohm respectively. The value of shunt to be connected to 3 ohm resistor to shift the balancing point by 22.5 cm is

1) 3 ohm 2) 1 ohm 3) 2 ohm 4) 2.5 ohm

3. The resistances in the left and right gaps of a balanced meter bridge are R_1, R_2. The balance point is 50cm. If a resistance of 24ohm is connected in parallel to R_2, the balance point is 70cm. The value of R_1 is

1) 2 ohm 2) 8 ohm 3) 12 ohm 4) 32 ohm

4. In Meter Bridge when P is kept in left gap, Q is kept in right gap, the balancing length is 40cm. If Q is shunted by 10, the balance point shifts by 10cm. Resistance Q is

1)1 ohm 2) 5 ohm 3) 10 ohm 4) 6 ohm

5. A battery of negligible internal resistance is connected with 10m long wire. A standard cell gets balanced on 6m length of this wire. On increasing the length of Potentio meter wire by 2m, the null point with the same standard cell in the secondary will be

1) Increased by 2m 2) decreased by 2m
3) Increased by 1.2m 4) decreased by 1.2m

6. A potentiometer has a wire of 100cm length and its resistance is 10 ohms. It is connected in series with a resistance of 40 ohms and a battery of emf 2V and negligible internal resistance. If a source of unknown emf connected in the secondary is balanced by 40cm length of potentiometer wire, the value of 'E' is

1) 0.8V 2) 1.6V 3) 0.08V 4) 0.16V

7. A constant resistance is kept in the left gap of a meter bridge. For two different resistances separately in right gap, the balancing length are 40 & 60cm. If these two are connected in series in right gap, the balancing length is

1) 20 cm 2) 30 cm 3) 40cm 4) 45 cm

8. When resistances x & y are connected in the left and right gaps of a meter bridge balancing point is obtained 50 cm. when x is increased by same x and y is increased by y, then the new balance point is

1) 20 cm 2) 40 cm 3) 50 cm 4) 80 cm

9. Two resistances X & Y are in the left and right gaps of a meter bridge. The balancing point is 40cm from left. Two resistances of 10 Ohm each are connected in series with X & Y separately. The balance point is 45cm. The X and Y are

1) 2 & 8 Ohms 2) 4 & 6 Ohms
3) 8 & 12 Ohms 4) 12 & 16 Ohms

10. In a meter bridge experiment, when the resistances in the gaps are interchanged the balance point is shifted by 10cm. The ratio of the resistance is

1) 15:5 2) 12:8 3) 11:9 4) 10:9

11. A Potentiometer wire of length 10m has a resistance of 10 ohm. It is connected in series with a resistance and a cell of emf 4V. A cell of emf 1.5V is balanced against a length of 4.5m of the potentiometer wire. The external resistance is

1) 4 ohm 2) 2 ohm
3) 5 ohm 4) 10 ohm

12. In an experiment for calibration of voltmeter, a standard cell of emf 1.5V is balanced at 300cm length of potentiometer wire. The P.D. across a resistance in the circuit is balanced at 1.25m. If a voltmeter is connected across the same resistance, it reads 0.6V. The error in the voltmeter is

1) 0.05V 2) 0.025V 3) 0.5 V 4) 0.25V

13. A potentiometer wire of 1m length and 10 Ohm resistance is connected in series with a cell of emf 2V and internal resistance 1Ohm and a resistance box having a resistance R. If the P.D. between the ends of the wire is 1 millivolt, the value of R in ohms is

1) 19989 2) 9989
3) 20,000 4) 10,000

14. A 1Ohm resistance is in series with an A mmeter which is balanced by 75cm of potentiometer wire. A standard cell of 1.02 V is balanced by 50cm. The Ammeter shows a reading of 1.5A. The error in the Ammeter reading is

1) 0.002A 2) 0.03A
3) 1,01A 4) no error

15. The balancing length for a cell of emf 1.2 V and internal resistance 5 Ohm is 900 cm. If a 10 Ohm resistance is connected across the terminals of the cells, then the potential difference across resistance and balancing length will respectively be

1) 0.5V, 150 cm 2) 0.5 V, 600 cm
3) 0.8V, 300 cm 4) 0.8V, 600 cm

16. A potentiometer wire of length 10m and resistance 9.8ohm is connected in series with a battery of emf 2V and internal resistance 0.2Ohm . The balancing length 1st cell of emf 1V volt on this potentiometer is 4m. When 2ohm resistance is connected in series with the potentiometer, wire, then the change in balancing length is –

1) Decreases by 0.8m 2) Increases by 1m
3) Decreases by 1m 4) Increase by 0.8 m

17. An uniform conducting wire of 16ohm resistance is stretched uniformly so that its length increases by 50 percent. Then it is bent in the form of a square. A battery of e.m.f 1 volt, internal resistance one ohm is connected between two opposite corners. A resistance of 10ohm is connected between other two opposite corners, current flowing through one of the sides of square (in ampere) is

1) 1.2A 2) 0.6A 3) 0.3A 4) 6A

18. A 10 m long wire of resistance 15 ohm is connected in series with a battery of emf 2V (no internal resistance) and a resistance of 5 ohm. The potential gradient along the wire is

1) 0.15 Vm^{-1} 2) 0.45 Vm^{-1}

3) 1.5 Vm^{-1} 4) 4.5 Vm^{-1}

19. In a potentiometer experiment, when two cells are joined in series to support each other and then joined to oppose each other balancing points are obtained at 6m and 2m respectively. The ratio of their e.m.f. s is

1) 1:1 2) 2:1 3) 3:1 4) 4:1

20. A cell in the secondary circuit given balancing length for 1.5 m length in potentiometer of length 10m. If the length of potentiometer is increased by 1m without changing the cells in primary or secondary, balancing length becomes

1) 1.5 m 2) 1.65m 3) 3m 4) 3.5 m

21. In an experiment to determine the internal resistance of a cell with potentiometer, the balancing length is 260 cm. When a resistance of 3 ohm is joined in parallel with the cell, the balancing length is 150 cm. The internal resistance of the cell is

1) 2.2 ohm 2) 1.1 ohm

3) 3.3 ohm 4) 3 ohm

22. A standard resistance of 1 ohm and a small resistance ‘r’ are connected in series. The balancing length on potentiometer wire corresponding to this combination is 630 cm whereas the balancing length corresponding to 1 ohm resistance is 600cm. The value of ‘r’ will be

1) 0.5 2) 1

3) 2 4) 0.05

23. If the applied emf in the primary circuit of a potentiometer is increased by 3 times, the value of potential gradient will become

1) one third 2) 3 times

3) 6 times 4) 9 times

24. The resistivity of a potentiometer wire is ‘ρ’ and the area of cross section of the wire is ‘A’. If the current flowing in the circuit is ‘I’, then potential gradient will be

1) $IA\rho$ 2) IA/ρ

3) $I\rho/A$ 4) $I/\rho A$

25. A potentiometer wire of 10m length and 20 ohm resistance is connected in series with a resistance of 80 ohm and a battery of emf 2V, negligible internal resistance. Potential gradient on the wire in millivolt/centimeter will be

1) 0.4 2) 0.16 3) 2 4) 4

26. A cell connected in the secondary circuit of potentiometer gives null point at 325cm. When another cell is connected in series with the cell, the null point is obtained at 550 cm. Ratio of e.m.f.s of the 2 cells is

1) 13:22 2) 13:9

3) 325:550 4) 65:43

27. The emf of a battery ‘X’ is balanced by a length of 80cm on a potentiometer wire. The emf of a standard cell 1V is balanced by 50cm. The emf of battery ‘X’ is

1) 1.4V 2) 1.5V 3) 1.6V 4) 2V

28. The resistance of the potentiometer wire is 0.9Ohm. The potential gradiant is $0.0081Vcm^{-1}$. Then the current in the wire is

1) 1A 2) 0.9A 3) 0.5A 4) 0.1A

29. In a potentiometer experiment, 2 cells of emf's E_1 and E_2 balances for a length of 800cm when they are in series. If the terminals of the cell of E_2 in reversed then the balancing length is 200cm. If $E_1 > E_2$, the ratio $E_1:E_2$ is

1) 4:1 2) 2:1 3) 5:3 4) 3:2

30. The resistances of 2 potentiometer wires of equal lengths are 2Ohm and 4Ohm respectively. If the currents flowing through them is same, the ratio of potential gradient is

1) 1:2 2) 2:1 3) 1:3 4) 1:1

31. A 2 ohm resistance and an unknown resistance are connected in series and constant current is flowing through them. In potentiometer experiment, the potential difference across 2 ohm resistance is balanced against 300cm length and that cross the unknown resistance is balanced against 360 cm length. The value of unknown resistance is

1)2.4 ohm 2) 3.6 ohm
3) 3.0 ohm 4) 6.6 ohm

32. In potentiometer experiment, a standard cell of 1.2 V emf gets balanced at 260 cm length of potentiometer wire. If a current of 0.2 A flows through 3 ohm resistance, the balancing length will be

1) 80cm 2) 130 cm 3) 520 cm 4) 260 cm

33. In an experiment with potentiometer to measure the internal resistance of a cell, when the cell is shunted by 5 resistance, the null point is obtained at 2m. When the cell is shunted by 20 resistance, the null point is obtained at 3m, The internal resistance of cell is

1) 2 2) 4
3) 6 4) 8

34. A potentiometer wire of length 10m and resistance 30Ohm is connected in series with a battery of emf 2.5V, internal resistance 5Ohm and external resistance R. If the fall of potential along the potentiometer wire is 50mV/m, the value of R in ohms is

1) 115 2) 80
3) 50 4) 100

35. A potentiometer has a wire of 100 cm length and its resistance is 10 ohms. It is connected in series with a resistance of 40 ohms and a battery of emf 2V and negligible internal resistance. If a source of unknown emf connected in the secondary is balanced by 40cm length of potentiometer wire, the value of 'E' is

1) 0.8V 2) 1.6V
3) 0.08V 4) 0.16 V

36. The emf of a cell is 2V and its internal resistance is 2 ohm. A resistance of 8 ohm is joined to battery. If 1V standard cell balances for 100cm of potentiometer wire, the balance point of above cell is

1) 120cm 2) 240cm
3) 160cm 4) 116cm

37. If the length, thickness specific resistance and current flowing in a potentiometer wire are doubled, then potential gradient becomes – times

1) 4 2) 8

3) 2 4) uncharged

SEMI COUNDUCTOR ELECTRONIC DEVICES AND CIRCUITS

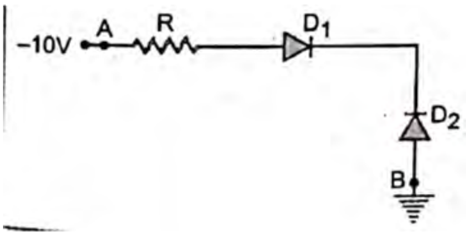
1. What will happen to the size of the depletion region in the forward bias of a p-n junction diode?
2. What will happen to the barrier potential when the Zener diode is forward biased
3. Zener diode is used as a voltage
   (a) rectifier (b) regulator (c) amplifier (d) oscillator

4. Singe p – n junction diode can be used in electronic circuit as
   (a) Full wave rectifier (b) Half wave rectifier (c) filter (d) switch
5. Symbol of p – n junction diode is
6. Symbol of Zener diode
7. Threshold voltage or cut in voltage in Germanium diode is
   (a) ~ 0.2 V (b) ~ 0.3 V (c) ~ 0.4 V (d) ~ 0.5 V
8. The direction of diffusion current in an unbiased p-n junction diode is.
9. The current is reverse bias of a p-n junction diode is in the order of
   (a) Micro Ampere (b) Nano Ampere (c) mille Ampere (d) Pico ampere
10. Number of p-n junction diodes used in a full wave rectifier
    (a) One (b) two (c) Three (d) four
11. The frequency of pulsating (unsteady) DC in a half wave rectifier is
    (a) Equal to the frequency of AC
    (b) Double the frequency of AC
    (c) No relation with AC frequency
    (d) It needs calculation
12. The direction of drift current in an unbiased p-n junction diode is
13. When a photo diode is in use it is biased as
    (a) Forward bias (b) Reverse bias (c) unbiased (d) It can be any biasing
14. The I-V characteristics of a photo diode are drawn in the
    (a) First quadrant (b) Second quadrant (c) Third quadrant (d) Fourth quadrant
15. The photons emitted in LED are
    (a) Equal or slightly less than the band gap
    (b) Equal or slightly greater than the band gap
    (c) Equal to the band gap
    (d) Doesn’t depend on the band gap
16. If the forward current on LED increases
    (a) Intensity of emitted light increases

(b) Intensity of emitted light decreases
(c) Intensity of emitted light has no relation with the forward current
(d) None of the above

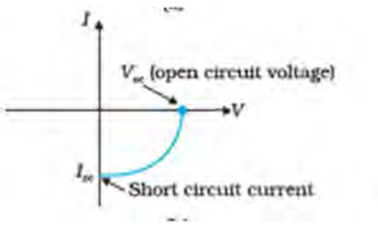
17. The composition of Gallium , Arsenic and Phosphorus in Red LED is
18. The energy band gap required to produce Infra Red LED is
19. Condition to generate electricity in a solar cell is
    (a) (a) $h\nu > E_g$ (b) $h\nu < E_g$ (c) $h\nu = E_g$ (d) $h\nu - E_g$
20. The typical I-V characteristics of a solar cell are drawn in
21. The current in forward bias is in the order of
    (a) Micro Ampere (b) Nano Ampere (c) mille Ampere (d) Pico ampere

22. Assuming the diodes to be ideal



    (a) D_1 is forward biased D_2 is reverse biased and hence current flows from A to B
    (b) D_2 is forward biased and D_1 is reverse biased and hence no current flows from B and A and vice versa
    (c) D_1 and D_2 are both forward biased and hence current flows from A to B
    (d) D_1 and D_2 are both reverse biased and hence no current flows A to B and vice versa.
23. In the depletion region of a diode
    (a) There are no mobile charges
    (b) Equal number of holes and electrons exist making the region neural
    (c) Recombination of holes and electrons has taken place
    (d) Immobile charged ions exist.

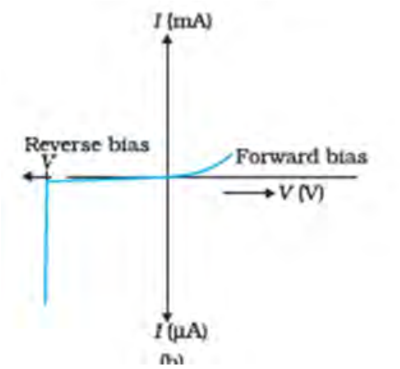
24.



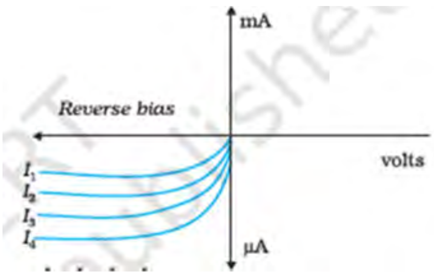
The given graph represents I – V characteristic for a semiconductor device. Which of the following is correct ?
    (a) It is I _ V characteristic for solar cell where point A represents open circuit voltage and point B short circuit current

(b) It is for a solar cell and points A and B represent open ciucuit voltge and current respectively
(c) It is for photodiode and points A and B represent open circuit voltage and current respectively
(d) It is for LED and points A and B represent open circuit voltage and short circuit current respectively
(e) It is for LED and points A and B represent open circuit voltage and short circuit current respectively.

25. Zener diode is designed to operate under
    (a) Forward bias (b) Reverse bias (c) No bias (d) None of the above
26. The size of depletion region is in the order of
    (a) (a) $<10^{-6}$ (b) $> 10^{-6}$ (c) $= 10^{-6}$ (d) No such relation exists
27. The magnitude of junction field in a Zener diode is of the order of
    (a) (a) $\sim 5x10^{6}$ V/m (b) $= 5x10^{6}$ V/m (c) $\sim 5x10^{7}$ V/m (d) $\sim 5x10^{-6}$ V/m
28. In the graph given below is the I – V characteristic of a special purpose p-n junction diode, identify the diode

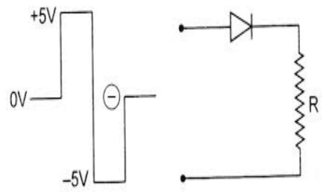


29. The current in Zener diode increases sharply after Zener voltage. The charges required for this current are drawn from
    (a) Conduction band (b) Valence band (c) Forbidden band (d) Fermi level
30. What is the purpose of using a transparent window in a photodiode?
31.



The graph shown above is for a photodiode, where I_1,I_2,I_3,I_4 represent the intensity of light incidenting on the junction of photo diode. Which intensity of light produces highest photo current?

32. The reverse breakdown voltages of LED are very low, typically around
    (a) 5 V (b) 6V (c) 7V (d) 8V
33. The light is emitted in LED due to
34. In a solar cell the thickness of p – Si wafer is about
    (a) 300 µm (b) 200 µm (c) 100 µm (d) 25 µm
35. In a solar cell the thickness of n – Si wafer is about
    (a) ~0.5µm (b) ~ 0.7µm (c) ~0.3 µm (d) ~ 0.8µm
36. Why photo diodes is always connected in reverse bias.
37. What is the size of Zener Diode?
    (a) Its size remains constant (b) Its size is bigger than the p-n junction diode
    (c) Its size is smaller than the p-n junction diode (d) Its size changes according to the requirement of the circuit
38. Symbol for LED is
39. In the figure shown above which end is p- type material and which is n type material
40. Which semi conductor is used in making Blue LED
41. In a conductor conduction and valance bands are ________
42. Semiconducting device used to regulate an uninterrupted dc power supply is _______________
43. GaAs is used in __________ diode
44. Zener diode works in ____________ bias
45. The energy gap when doped with a pentavalent impurity
    a) increases b)decreases c) remains the same
46. In an n type semiconductor n_e/n_h is
    a) <1 b) >1 c) =1
47. Electrical conductivity of a pure semiconductor at a given temperature depends
    a) Width of forbidden and b) intrinsic charge carrier concentration. c) both d) none
48. Output in the following is a) 5V b) -5 V c) 0 V d) 1 V

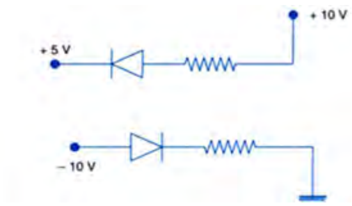


49. Beyond zener breakdown voltage when current changes voltage a) increases b) decreases c) no change

50. In forward bias of junction diode width of depletion region a) decreases b) increases c) does not change.
51. The conductivity of n- type semi conductor is __________ than p-type semiconductor though the concentration is the same of both the charges?
52. _____________ are prefered for fabrication of solar cells?
53. In a p-n jn diode, increase in forward voltage of 0.19 v increases forward current by 37.6 mA. dynamic resistance is ___________

54. A zener diode is specified havivg breakdown voltage of 9.1V with maximum power dissipation of
364mW. The maximum current the diode can handle is ____________
55. The diodes in figure are
a) both forward bias b) both reverse bias c) forward and reverse bias
d) reverse bias and forward bias

(ii)



56. In half wave rectifier output power is ______%
57. In full wave rectifier output power is ______%
58. In insulators the forbidden energy gap is ____________
59. Pure Si at 300 K has equal electron and hole concentration of 1.5×10^{16} /m^3. Doping by Indium increases hole concentration to 4.5×10^{22}/m^3 electron concentration is ________
60. Drift current in a semi conductor is due to ___________________________________
61. Diffusion current in a semi conductor is due to ___________________________________
62. In intrinsic semiconductors ratio of electron hole concentration is
a) <1 b) >1 c) =1
63. In n-type semiconductor additional energy levels are formed _______________________
64. Voltage in forward bias of a p-n diode where current abruptly increas is _______________
65. LED works in __________bias.
66. Hole concentration of a diode is the ratio of charge concentration to ______________
67. Maximum wavelength of electromagnetic radiationton to create electron-hole pair in silicon with band gap 1.1 eV is _____________
68. In a pure semiconductor number of conduction electrons is 6×10^{19} per m^3. How many holes are there in a sample of 1cm x 1cm x 2mm
69. Increase in tempature of a semiconductor _______ the forbidden gap
a) increases b) decreases c)will not change d)will double
70. Diamond behave like
a) conductor b) insulator c) semiconductor
71. Reverse bias of a pn jn diode
a) increases b) decreases c) will not change the barrier voltage
72. Piece of cu is cooled from room temparature to 80 k its resistance
a) increases b) decreases c) no change
73. When a reverse voltage of 5V is applied across the depletion region (thickness < 10^{-6} m)of a Zener diode , find the field set up across the junction __________________
74. Solar cell works in ____________bias
75. The colour of light emited in LED depends on
a) Level of doping b) semiconductor used c) both d)none

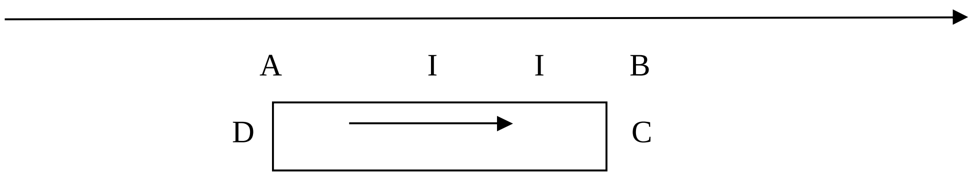
MAGNETIC EFFECTS OF CURRENT AND MAGNETISM

1. State Biot-Savart law.
2. Write mathematical expression for Biot-Savart law in vector form.
3. Name the SI unit of the magnetic field and define it.
4. Write mathematical expression for magnetic field at the centre of a current carrying circular coil.
5. On what factors the magnetic field at the centre of a current carrying coil depends?
6. Name and state the rule for finding the directions of a magnetic field due to a circular current loop.
7. State ampere's circuital Law. Give its mathematical expression.
8. Write the mathematical expression for the magnetic field produced by an infinitely long straight conductor.
9. What is meant by solenoid? Give mathematical expression for magnetic field produced by it at its centre.
10. State the rule which is used to find the direction of force on a charge moving in a per pendicular magnetic field.
11. What is meant by Lorentz Force? Give its mathematical expression.
12. Write the expression for force acting on any charge q and velocity v that enters in magnetic field in vector form.
13. Name the physical quantity whose SI unit is wb/m^2.
14. Under what condition does an electron moving through a magnetic field experience maximum force?
15. Under what condition is a force acting on a charge moving through a uniform magnetic field minimum?
16. What is the direction of the force acting on a charged particle Q moving with a velocity V in a uniform magnetic field B?
17. What will be the path of a charged particle moving perpendicular to a uniform magnetic field?
18. Among alpha, beta and gamma radiations which get deflected by a magnetic field?
19. Electron being projected along the positive X- axis experience is a force due to magnetic field along the Y-axis. What is the direction of magnetic field?
20. A beam of Alpha particles projected along the positive X- axis experiences a force due to a magnetic field along the positive y-axis. What is the direction of the magnetic field?
21. Which of the following will experience maximum force when projected with the same velocity v perpendicular to the magnetic field (i) Alpha particle or (ii) beta particle?
22. A solenoid coil of 300 turns/m is carrying a current of 5A. The length of the solenoid is 0.5m and has a radius of 1cm. Find the magnitude of magnetic field inside the solenoid.
23. An electron does not suffer any deflection while passing through a region of uniform magnetic field. What is the direction of the magnetic field?
24. What amount of work is done by a magnetic force in a moving charge and why?
25. What is the SI unit of Permeability μ_0?
26. What is the value of $4\pi/ \mu_0$?
27. What is Cyclotron.
28. State the principle of a cyclotron.

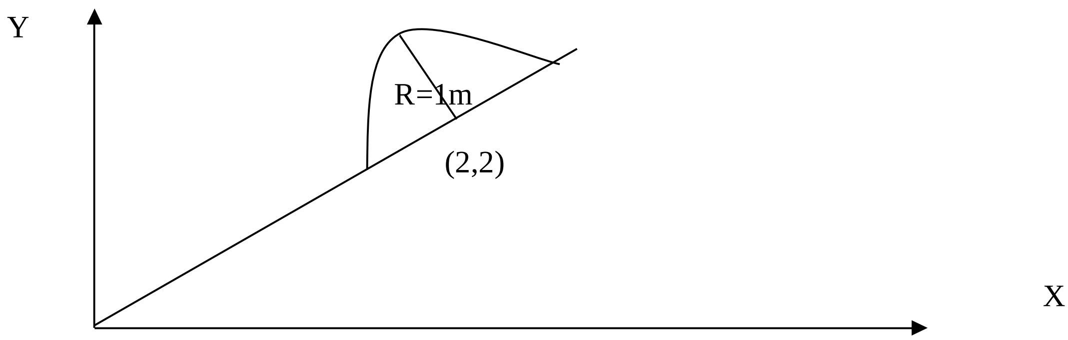
29. What is the function of electric field in cyclotron?
30. What is the function of magnetic field in cyclotron?
31. Can we accelerate neutrons using cyclotron? Give reason.
32. The frequency of revolution of a charged particle in a cyclotron does not depend on the speed of the particle. Why?
33. Why is cyclotron not suitable for accelerating electrons?
34. An electron and a proton having equal momenta are moving at right angles to the field lines. What will be the ratio of curvature of their trajectories?
35. On what factors the Cyclotron frequency depends?
36. Mention any one use of Cyclotron.
37. Write the relation between ϵ_0, μ_0 and c.
38. What is the SI unit of the product of ϵ_0 and μ_0?
39. A straight conductor AB of a circuit lies along the x-axis from x = -a/2 to x = +a/2 and carries a current I. What is the magnetic field due to this conductor AB at a point x = +a.
40. An electric current is flowing due south along a power line. What is the direction of the magnetic field at a point above it?

SNo	**QUESTIONS**
41	The scale of galvanometer of resistance 100Ω contains 25divisions. It gives deflection of one division on passing current of $4X10^{-4}$A. The resistance in ohm to be added to it , so that it may becomes a voltmeter of range 2.5V is
A	150
B	170
C	110
D	220
42	A galvanometer coil has a resistance of 10Ω and the meter shows full scale deflection for A current of 1mA. The shunt resistance required to convert the galvanometer into an ammeter of range 0 to 100mA is about
A	10Ω
B	1Ω
C	0.1Ω
D	0.01Ω
43	If the number of turns in the moving coil galvanometer becomes half , then the deflection For the same current will be become
A	Same
B	Half
C	Double
D	Four times
44	A voltmeter has a resistance of GΩ and range of V volts. The value of resistance used in series to convert it into a voltmeter of range nV volts is
A	nG
B	(n-1)G
C	G/n
D	G/(n-1)
45	A conducting circular loop of radius r carries a constant current I. It is placed in a uniform Magnetic field B such that B is perpendicular to the plane of the loop. The magnetic force

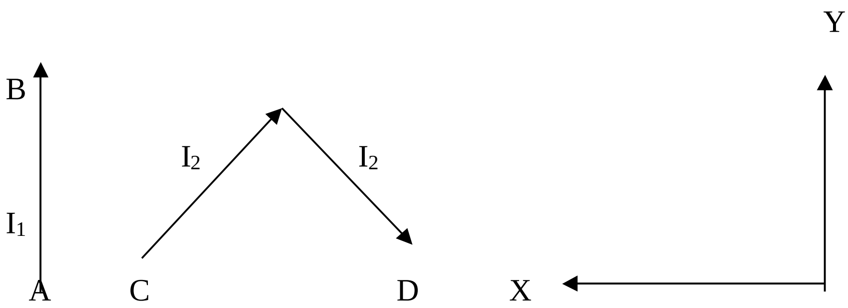
	acting on the loop is
A	IRB
B	$2\pi RIB$
C	Zero
D	πRIB
46	A rectangular loop carrying a current I is situated near a long straight wire such that the wire is parallel to one of the sides of the loop and the plane of the loop is same of the straight wire. If a steady current I is established in the wire as shown, the loop will
A	Rotate
B	Move away from the wire
C	Move towards the wire
D	Remain stationary



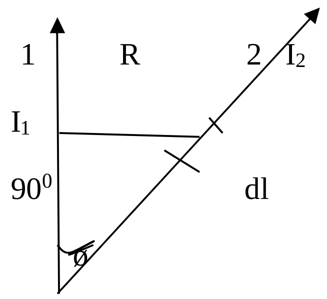
47	A uniform magnetic field B (3i+4j+k) exists in region of space. A semicircular wire of radius 1m carrying current 1 A having its centre at (2,2,0) is placed in x-y plane as shown. The force on the semicircular wire will be
A	$2^{1/2}(i+j+k)$
B	$2^{1/2}(i-j+k)$
C	$2^{1/2}(i+j-k)$
D	$2^{1/2}(-i+j+k)$



48	Two thin long parallel wires separated by a distance b are carrying a current IA each. The magnitude of the force per unit length exerted by one wire on the other is
A	$\mu_0 I^2/b^2$
B	$\mu_0 I^2/2\pi b$
C	$\mu_0 I/2\pi b$
D	$\mu_0 I/2\pi b^2$
49	In the figure shown a current I, is established in the long straight wire AB. Another wire CD carrying current I_2 is placed in the plane of the paper. The line joining the ends of this wire is perpendicular to the wire AB. The resultant force on the wire CD is

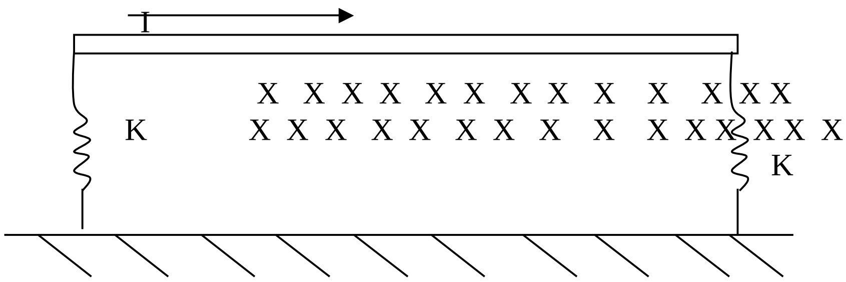
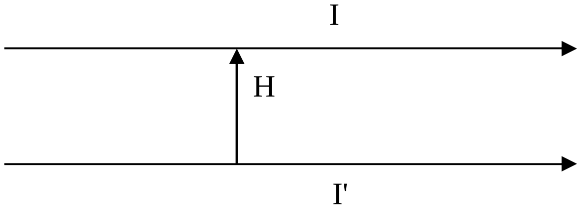


A	Zero
B	Towards negative X-axis
C	Towards + ve Y axis
D	None of this
50	A bar magnet has magnetic moment 2.5J/T and is placed in a magnetic field of 0.2 T. Work done in turning the magnet from parallel to anti parallel position relative to the field direction.
A	0.5J
B	1J
C	2.0J
D	Zero
51	A circular loop of area $1cm^2$, carrying a current of 10A is placed in a magnetic field of 0.1T perpendicular to the plane of the loop. The torque on the loop due to magnetic field is
A	Zero
B	10^{-4}Nm
C	10^{-2}Nm
D	1Nm
52	Wires 1 and 2 carrying currents I_1 and I_2 respectively are inclined at an angle ø to each other. What is the force on a small element dl of wire 2 at a distance r from wire 1, due to the magnetic field of wire 1?

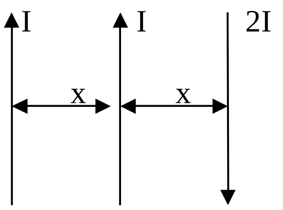
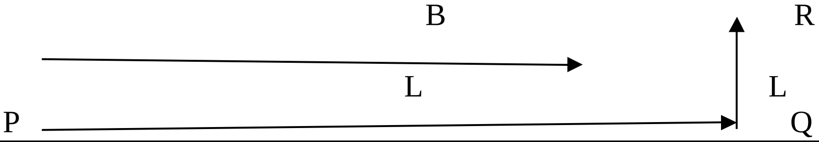


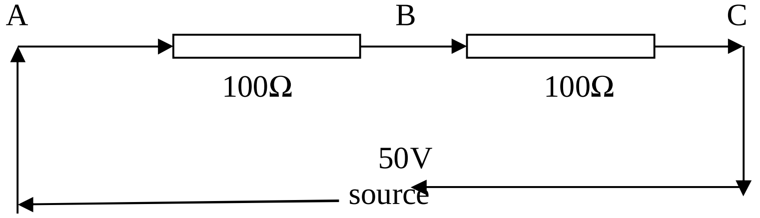
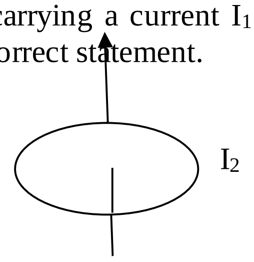
A	$(\mu_0 I/2\pi R)I_1I_2dl$ Tanø
B	$(\mu_0 I/2\pi R)I_1I_2dl$ Sinø

C	$(\mu_0 I/2\pi R)I_1I_2dl$ Cosø
D	$(\mu_0 I/4\pi R)I_1I_2dl$ Sinø
53	A thin flexible wire of length L is connected to two adjacent fixed points carries a current I in the clock-wise direction. When the system is put in a uniform magnetic field strength B going into the plane of paper it takes the shape of the circle. The tension in the wire is
A	IBL
B	IBL/π
C	IBL/2π
D	IBL/4π
54	A magnetic needle lying parallel to a magnetic field requires W units of work to turn it through 60^0 . The torque needed to maintain the needle in this position will be
A	$3^{1/2}W$
B	W
C	$(3^{1/2}/2)W$
D	2W
55	Magnetic lines of force inside a bar magnet-
A	Do not exists
B	Depend upon the area of cross section
C	Are from south pole to North pole
D	Are from North pole to South pole
56	A current I A flows along an infinitely long straight thin walled tube, then the magnetic induction at any point inside the tube is
A	Zero
B	Infinite
C	$\mu_0 2I/4\pi r$
D	2I/r
57	Two long conductors separated by a distance d carry currents I_1 and I_2 in the same direction. They exert a force F on each other. Now the current in one of them is increased to two times and its direction is reversed. The distance is also increased to 3d. The new value of the force between them is-
A	-2F
B	F/3
C	-2F/3
D	-F/3
58	A magnetic needle is kept in a non uniform magnetic field. It experiences
A	A Torque but not force
B	Neither a force nor a torque
C	A force and a torque

D	A force but not torque
59	A magnetic dipole M= (Ai+Bj)J/Wb is placed in magnetic field B=$(Cx^2i+D\ y^2j)$Wb /^{m2} ^{in}XY plane at r= (Ei+Fj)m. Then force experienced by the dipole is
A	2ACEi+2BDFj
B	2ACEj
C	0
D	ACEi+BDFJ
60	A horizontal metallic rod of mass m and length l is supported by two vertical identical springs of spring constant K each and natural length l_0. A current I is flowing in the rod in the direction shown. If the rod is in equilibrium then the length of each spring in this state is 
A	L_0 +(BIL-mg)/K
B	L_0 +(BIL-mg)/2K
C	L_0 +(mg-BIL)/2K
D	L_0 +(mg-BIL)K
61	A wire carrying current I and has linear mass density μ should be floated in the air. In which direction and how much magnetic field should be applied Current is passing left to right.
A	μg/I into the plane
B	μg/I vertically upward
C	μg/IL into the plane
D	μg/I L vertically upward
62	How much should be the current passed through lower wire so that the upper wire of linear mass m should remain in air at height h while carrying current I 
A	I' =$2\pi mgh/\mu_0 I$

B	Not possible
C	$4\pi mgh/ \mu_0 I$
D	Zero
63	A metal rod of cross section area a carrying current I is supported to flout in air by the help of magnetic field B. Next it is immersed in a liquid and again maintained to remains suspended by applying same field, but the current had to be passed through the rod is I'. Find the density of the liquid
A	D=B(I-I')/ag
B	$D=B(I-I')/ag^2$
	$D=B(I-I')/ag^3$
D	None of these
64	Circular coil of radius R and a current I which can rotate a about a fixed axis passing through its diameter is initially placed such that its plane lies along magnetic field B. Kinetic energy of the loop when it rotates through an angle 90^0 is
A	$\pi R^2 BI$
B	$\pi R^2 BI/2$
C	$2\pi R^2 BI$
D	$3/2(\pi R^2 BI)$
65	A galvanometer of resistance 25Ω is shunted by a 2.5 Ω wire. The part of total current that flows through the galvanometer is
A	$I/I_0 = 1/11$
B	$I/I_0 = 3/11$
C	$I/I_0 = 2/11$
D	$I/I_0 = 4/11$
66	In the figure the loop is fixed but straight wire can move, the straight wire will be
A	Remain stationary
B	Move towards the loop
C	Move away from the loop
D	Rotate about the axis
67	What kind of field should be established in the M C G?
A	Radial
B	Uniform
C	Non uniform
D	None of these
68	If we increase the number of turns of the coil of the moving coil galvanometer what happens to the sensitivity?
A	Current sensitivity remains constant but voltage sensitivity changes
B	Current sensitivity increases but voltage sensitivity remains same

C	Both does increase
D	No change
69	In an ammeter 10% of main current is passing through the galvanometer. If the resistance of the galvanometer is G, then the shunt resistance -
A	9G
B	G/9
C	90G
D	G/90
70	A M C G has a coil of effective area A and no. of turns N. The magnetic field B is radial. If a current I is passed through the coil the torque acting on the coil is
A	NA^2B^2I
B	NABISinø
C	NABI
D	Zero
71	The sensitivity of MCG can be increased by decreasing
A	No. of turns of the coil
B	Magnetic field
C	Area of the coil
D	Restoring couple per unit twist of the suspension
72	A, B, and C are parallel conductors of equal lengths carrying currents I, I and 2I respectively. F1 is the force exerted by B on A. F2 is the force exerted by C on A. Choose correct statement 
A	F1 = 2F2
B	F2=2F1
C	F1=F2
D	F1=-F2
73	A wire PQR is bent as shown as PQ=L and QR= L and carrying current I , placed in uniform magnetic field B. The magnitude of the force on PQ and QR will be- 
A	BIL,0
B	2BIL,0

C	0,BIL
D	0,0
74	Consider the diagram  A Voltmeter of resistance 150Ω is connected across A and B. The P.D across B and C measured by voltmeter is
A	29V
B	27V
C	31V
D	30V
75	When a current carrying coil placed in a uniform magnetic field with its magnetic moment anti parallel to the field then
A	Torque on it maximum
B	Torque on it zero
C	Potential Energy maximum
D	Dipole is in unstable equilibrium
76	A loop of magnetic moment M is placed in the orientation of unstable equilibrium position in a uniform magnetic field B. The external work done in rotating it through an angle ø is
A	-MB(1-cosø)
B	-MB cosø
C	MB cosø
D	Mb(1-cosø)
77	Figure shows a line straight wire carrying a current I_1 along the axis of a circular ring carrying a current I_2. Identify the correct statement. I_1 
A	Straight wire attracts the ring
B	Straight wire attracts a small element of thering
C	Straight wire does not attract any small element of the ring
D	None of the above

78	A metal ring of radius r = 0.5 m with its plane normal to a uniform magnetic field B of induction 0.2 T carries a current I = 100 A. The tension in Newton developed in the ring is
A	100
B	50
C	25
D	10
79	There are two wires of infinite length carrying currents I and 3I placed parallel to each other at 5m and 2m from point A. If an α particle is projected with velocity 10^5 m/s along y-direction through the point A. It is observed that it experiences the force 10^{-20}N, find the value of current I. X_(I)______________________X (3I) .A Current wire current wire point
A	1.3mA
B	2.9mA
C	5mA
D	919mA
80	What are uses of iron core in the MCG
A	It increases the strength of the magnetic field and makes it radial
B	It makes field in to uniform
C	It increases the weight of the MCG
D	No use

MAGNETISM AND MATTER

1. Which is not correct about the poles of a bar magnet ?
   (a) Poles of a magnet are of equal strength
   (b) Poles exit always in pairs
   (c) Poles of a magnet are always unlike
   (d) Poles situated outside the geometrical ends of a magnet

2. The pole strength of a bar magnet depends upon
   (a) Nature of the material of the magnet only
   (b) Area of cross-section of the magnet only
   (c) Both (a) and (b)
   (d) None

3. SI Unit of magnetic pole strength is
   (a) A-m

(b) A-m^{-1}
(c) A-m^{2}
(d) A-m^{-2}

4. Does the mono-pole exits?

5. Does the length of an iron bar change when it is magnetized?

6. Is copper a magnetic or non-magnetic material?

7. The direction of magnetic dipole moment of a bar magnet is
   (a) From south pole to north pole
   (b) From north pole to south pole
   (c) Perpendicular to axis of the bar magnet
   (d) None

8. A bar magnet of dipole moment 'M' cut into two equal parts along its axis. What is the new dipole moment of each part?
   (a) $\frac{M}{2}$
   (b) $\frac{M}{4}$
   (c) $\frac{M}{6}$
   (d) $\frac{M}{8}$

9. A steel wire has a magnetic moment 'M' and bent into a semi-circular arc shape. What is its new dipole moment?
   (a) $\frac{M}{2}$
   (b) $\frac{M}{2\pi}$
   (c) $\frac{2M}{\pi}$
   (d) Zero

10. Two bar magnets of dipole moments M_1. M_2 respectively are placed at right angles to each other with the north pole of one touching the south pole of the other. What is the magnetic dipole moment of the system?
    (a) $M_1 + M_2$
    (b) $M_1 – M_2$
    (c) $\sqrt{M_1^2 + M_2^2}$
    (d) $\sqrt{M_1 + M_2}$
11. What is the basic difference between magnetic and electric lines of force?

(a) Magnetic lines of force are closed and continuous but electric lines of force are open and continuous
(b) Magnetic lines of force are open and discontinuous but electric lines of force are open and continuous
(c) Both are closed and discontinuous
(d) Both are open and discontinuous.

12. Give one example for a magnet with no pole?

13. Can two magnetic lines of force intersect each other?

14. What is Gauss law in magnetism?
(a) The net magnetic flux through any closed surface is non-zero.
(b) The net magnetic flux through any closed surface is zero.
(c) The magnetic field inside a closed surface is zero.
(d) None of the above.

15. What is the significance of Gauss law in magnetism?

16. SI unit of magnetic field induction
(a) Weber
(b) Tesla
(c) Gauss
(d) Both (b) and (c)

17. 1 tesla = -----gauss
(a) 10^2
(b) 10^4
(c) 10^6
(d) 10^8

18. The north pole of a bar magnet is pointed towards the geographic north, then
(a) One neutral point is obtained on axial line.
(b) One neutral point is obtained on equatorial line.
(c) Two neutral points are obtained on equatorial line.
(d) Two neutral points are obtained on axial line.

19. The south pole of a bar magnet is pointed towards the geographic north, then
(a) One neutral point is obtained on axial line.
(b) One neutral point is obtained on equatorial line.
(c) Two neutral points are obtained on equatorial line.
(d) Two neutral points are obtained on axial line.

20. A pole of strength ‘m’ is placed in a magnetic field of induction ‘B’. What is the force experienced by it?
    (a) F = m B
    (b) F = $\frac{m}{B}$
    (c) F= $\frac{B}{m}$
    (d) F = $\frac{1}{2}\frac{m}{B}$

21. A magnetic pole of strength 10 A-m is placed in a magnetic field and experiences a force of 100 N. What is the magnetic field intensity?
    (a) 0.1 T
    (b) 1 T
    (c) 10 T
    (d) 100 T

22. The magnetic field induction at a point on the axial line of a short bar magnet is
    (a) B = $\frac{\mu_0}{4\pi}\frac{2M}{r^3}$
    (b) B = $\frac{\mu_0}{4\pi}\frac{M}{r^3}$
    (c) B = $\frac{\mu_0}{4\pi}\frac{2M}{r^2}$
    (d) B = $\frac{\mu_0}{4\pi}\frac{2M}{r^2}$

23. The magnetic field induction at a point on the equatorial line of a short bar magnet is
    (a) $\frac{\mu_0}{4\pi}\frac{2M}{r^3}$
    (b) B = $\frac{\mu_0}{4\pi}\frac{M}{r^3}$
    (c) B = $\frac{\mu_0}{4\pi}\frac{2M}{r^2}$
    (d) B = $\frac{\mu_0}{4\pi}\frac{2M}{r^2}$

24. The magnetic field induction due to a short bar magnet varies as
    (a) $\frac{1}{r}$
    (b) $\frac{1}{r^2}$
    (c) $\frac{1}{r^3}$
    (d) r^3
25. The ratio of magnetic field induction due to a short bar magnet on axial line and equatorial line for the same distance is
    (a) 1:2
    (b) 1:3
    (c) 2:3
    (d) 2:1

26. The magnetic field induction due to a short bar magnet on its end –on position is 10 T. What will be the magnetic field induction on broad-side position for the same distance is
    (a) 5 T
    (b) 15 T
    (c) 20 T
    (d) 25 T

27. The work done in moving a north pole of pole strength ‘m’ on the equatorial line of a bar magnet of dipole moment ‘M’ is
    (a) 0 J
    (b) 2 J
    (c) 4 J
    (d) 6 J

28. If the magnetic field is not uniform, the bar magnet will experience
    (a) Resultant force only.
    (b) Resultant torque only.
    (c) Both force and torque
    (d) Can’t predict.

29. If the magnetic field is not uniform, the motion of a bar magnet is
    (a) Translational only.
    (b) Rotational only.
    (c) Both translational and rotational
    (d) Can’t say.

30. A bar magnet is aligned parallel to the Earth’s magnetic field. What is the (a) net force and (b) net torque acting on it.
    (a) 0 N, 0 N-m
    (b) 0 N, 1 N-m
    (c) 1 N, 0 N-m
    (d) 1 N, 1 N

31. Write the vector form of the torque experienced by a bar magnet of dipole moment ‘M’ placed in an uniform magnetic field of induction ‘B’.

32. What are the conditions for a bar magnet to experience (a) a maximum and (b) minimum torque when it placed in an uniform magnetic field?
    (a) 0^0, 90^0
    (b) 90^0, 0^0
    (c) 45^0,60^0
    (d) 60^0,45^0

33. Two identical bar magnets are joined to form a cross (+). The combination is freely suspended in an uniform magnetic field of induction 'B'. At equilibrium one magnet makes an angle 'ϴ' with the field. What is 'ϴ'?
(a) 30^0
(b) 45^0
(c) 60^0
(d) 90^0

34. If a bar magnet of dipole moment 'M' is placed in an uniform magnetic field of induction 'B' and rotated from stable equilibrium position to unstable equilibrium position, then what will be the work done?
(a) 0
(b) +2 MB
(c) -2 MB
(d) +MB

35. What is the potential energy of a dipole when it is parallel to a magnetic field?
(a) 0
(b) –MB
(c) +MB
(d) +2 MB

36. The small angle between magnetic axis and geographic axis at a place is
(a) Magnetic meridian
(b) Magnetic inclination
(c) Magnetic declination
(d) None of the above

37. What is the angle of dip at a place where horizontal and vertical components of earth's field are equal?
(a) 30^0
(b) 45^0
(c) 60^0
(d) 90^0

38. What are the values of the angles of dip at (a) equator and (b) poles of the earth?

39. A circular coil of 1000 turns and diameter 14 cm carries a current of 10 A. What is the magnetic moment associated with it?

40. An electron of charge 'e' is revolving with a velocity 'v' in an orbit of radius 'r'. What is the magnetic moment associated with it?
(a) $\frac{evr}{2}$

(b) $\frac{evr}{2m}$
(c) $\frac{ev}{2r}$
(d) $\frac{evm}{2r}$

41. Which of the following is ferromagnetic
   a) Aluminium b) quartz c) nickel d) bismuth

42. An example of paramagnetic substances is
   a) Manganese b) iron c) copper d) water
43. If the magnetic moment of the atoms of a substance is zero, the substance is called
   a) Diamagnetic b) paramagnetic c) ferromagnetic d)antiferromagnetic
44. The magnetic materials having negative magnetic susceptibility are
   a) Non-magnetic b) paramagnetic c) diamagnetic d) ferromagnetic
45. The magnetic susceptibility for diamagnetic material is
   a) Small and negative c) small and positive
   b) Large and negative d) large and positive
46. Susceptibility is positive and small for a
   a) Paramagnetic b) ferromagnetic c) non-magnetic d) diamagnetic
47. Magnetic Susceptibility is maximum for
   a) Diamagnetic b) ferromagnetic c) paramagnetic d) non-magnetic
48. Susceptibility is positive and large for
   a) Paramagnetic substance c) non-magnetic substance
   b) Diamagnetic substance d) ferromagnetic substance
49. The core of an electromagnet is made of soft iron because soft iron has
   a) Small Susceptibility and small retentivity
   b) Large Susceptibility and small retentivity
   c) Large density and large retentivity
   d) Small density and large retentivity
50. Which of the following is most suitable for core of an electromagnet
   a) air b) soft iron c) steel d) Cu, Ni alloy
51. Steel is preferred for making permanent magnets because it has
   a) Large retentivity and large coercivity
   b) Small retentivity and small coercivity
   c) Large retentivity and small coercivity
   d) Small retentivity and large coercivity
52. All magnetic materials lose their magnetic properties when
   a) Dipped in water
   b) Dipped in oil
   c) Brought near a piece of iron
   d) Strongly heated

53. The area of hysteresis loop is an indication of the
   a) Permeability of the material
   b) Susceptibility of the material
   c) Retentivity of the material
   d) Energy dissipated per cycle
54. Most of the substance show which of the magnetic property
   a) Diamagnetism b) paramagnetism c) ferromagnetism d)none of the above
55. Core of electromagnets are made of ferromagnetic materials which have
   a) High permeability
   b) Low permeability
   c) Low retentivity
   d) Both a & c
56. The suitable material for making permanent magnets should have
   a) High retentivity
   b) High coercivity
   c) High permeability
   d) both a & b
57. The suitable material for making permanent magnets are
   a) Al; Fe b) steel c) alloys d)alnico, cobalt steel and ticonal
58. Ferromagnetic own their properties due to
   a) Filled inner shells
   b) Vacant inner sub-shell
   c) Partially filled inner sub-shell
   d) All the sub shells equally filled
59. Magnetism in a substance is caused by
   a) Orbital motion of the electrons only
   b) Spin motion of the electrons only
   c) Spin and orbital motion of electrons
   d) Hidden magnets
60. Earth's magnetic field always has a horizontal component except at
   a) Equator
   b) Geographical poles
   c) Magnetic poles
   d) None of the above

FILL IN THE BLANKS

61. Ferro magnetic materials used in transformer must have ___________ permeability and __________ hysteresis loss.
62. If the magnetism field on a ferromagnetic material is increased, its permeability is ___________.

63. Magnetic susceptibility is negative for ____________ material only
64. A paramagnetic sample shows a net magnetisation of 8 A/m when placed in an external magnetic field of 0.6T at a temperature of 4K. When the same sample is placed in an external magnetic field of 0.2T at a temperature of 16K, the magnetism will be _______________.
65. From Al, Bi, Cu, Na the paramagnetic materials are _____________ .
66. Which of the following substances (Copper, Aluminium, Sodium, Bismuth) are diamagnetic ________________ .
67. Which of the following substances (Al, Bi, Cu, Ca, Pb, Ni) are paramagnetic ___________.
68. The temperature of transition from Ferro magnetic to paramagnetism is called __________ temperature.
69. The relative permeability >1 for _________________ magnetic materials.
70. Can there be a material, which in non magnetic ?
71. ____________ substances are those which have tendency to move from stronger to weaker part of the external magnetic field.
72. Diamagnetic substances are the ones in which resultant magnetic moment in an atom is _________.
73. ______________ is present in all the substances.
74. The most exotic diamagnetic materials are ________________.
75. The phenomenon of perfect diamagnetism in superconductors is called the _____________.
76. ____________ substances are those which get weakly magnetized when placed in an external magnetic field.
77. ______________ substances have strong tendency to move from a region of weak magnetic field to strong magnetic field.
78. Alnico is an alloy of Fe, Al, Ni, Co & _____.
79. _________ iron is a suitable material for electromagnets.
80. The word hysteresis means _________________.

ELECTROMANGETIC INDUCTION

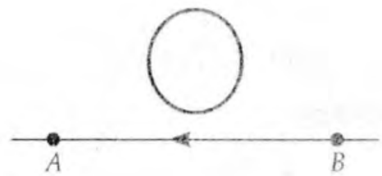
1. Whenever a magnet is moved either towards or away from a conducting coil, an e.m.f. is induced, the magnitude of which is independent of ( )
   (a) The strength of the magnetic field
   (b) The speed with which, the magnet is moved
   (c) The number of turns in the coil
   (d) The resistance of the coil
2. The magnetic flux linked with a coil (in Wb) is given by the equation:
   $\varphi = 5t^3 - 100t + 300$
   The induced e.m.f. in the coil at t = 2sec., will be ( )
   (a) 40V (b) –40V (c) 140V (d) 300V

3. In Lenz's law, there is conservation of ( )
(a) Charge (b) momentum (c) energy (d) current

4. Depict the direction of induced current in the loop when the current in the wire PQ is increasing.

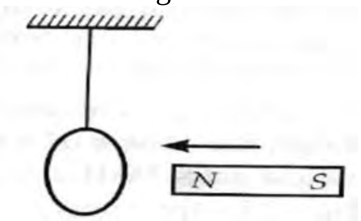
(a) Clockwise (b) anticlockwise (c) straight line (d) none of these ( )

5. What is the direction of induced current in the loop when the current in the wire BA is decreasing? ( )



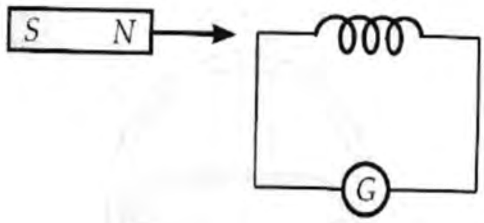
(a) Clockwise (b) anticlockwise (c) straight line (d) none of these

6. Give the direction in which the induced current flows in the wire loop (when seen from the magnet side), when the magnet moves towards it as shown in fig. ( )



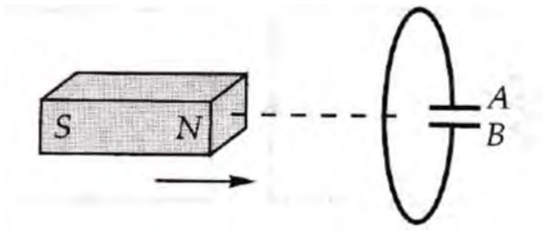
(a) Clockwise (b) anticlockwise (c) straight line (d) none of these

7. What will be the direction of induced current when a bar magnet is swiftly moved away from the coil (when seen from magnet side)? ( )



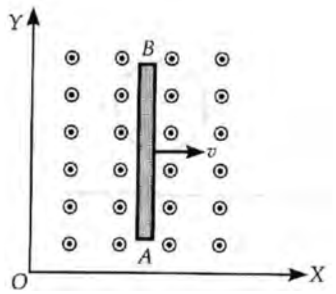
(a) Clockwise (b) anticlockwise (d) both clockwise and anticlockwise (d) straight line

8. What is the polarity of plate A and B of the capacitor, when a magnet is moved towards it (when seen from the magnet side)? ( )



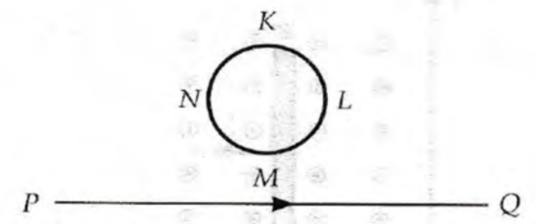
(a) Plate A has positive polarity and plate B has negative polarity
(b) Plate A has negative polarity and plate B has positive polarity
(c) Polarity cannot be developed on both the plates
(d) Both the plates develop positive polarity

9. A conducting rod AB moves parallel to X-axis in a uniform magnetic field, pointing in the positive Z-direction as shown in figure. The polarities developed on end A and end B will be ( )



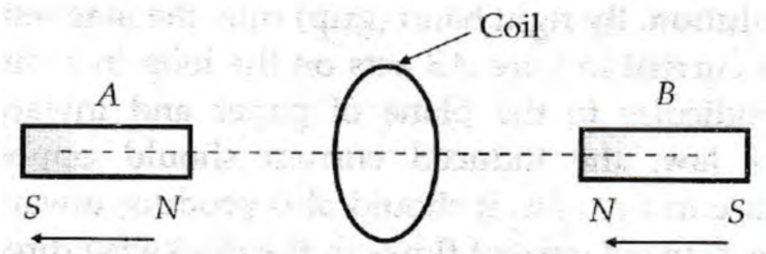
(a) Polarities cannot be developed at both the ends A and B
(b) Both the plates develop positive polarity
(c) End A develop positive polarity and end B develop negative polarity
(d) End A develop negative polarity and end B develop positive polarity

10. The magnitude of the induced current in the circular loop KLMN of radius 'r', if the straight wire PQ carries a steady current of magnitude 'i' ampere is ( )



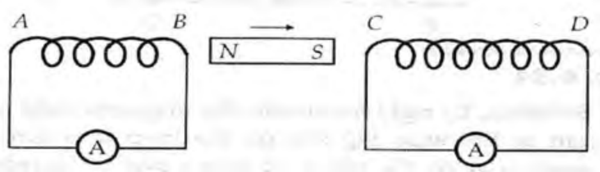
(a) Infinity (b) zero (c) i × r (d) none of these

11. In the given figure, A and B are identical magnets. Both the magnets are moving with the same speed as shown in figure. The induced e.m.f. in the coil is ( )



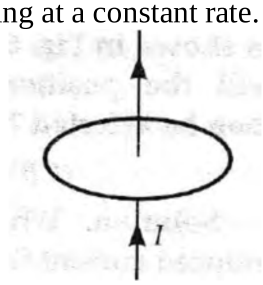
(a) Zero (b) infinity (c) data insufficient (d) none of these

12. A magnet is moved in the direction indicated by an arrow between two coils AB and CD as shown in figure. The direction of induced current in each coil is (when seen from the magnet side)



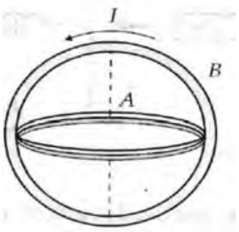
(a) The direction of induced current in coil AB is clockwise and coil CD is anticlockwise
(b) The direction of induced current in coil AB is anticlockwise and coil CD is clockwise
(c) The direction of induced current in both the coils will be in anticlockwise
(d) The direction of induced current in both the coils will be in clockwise ( )

13. The current I in a wire passing normally through the centre of a conducting loop is increasing at a constant rate. The induced current developed in the loop is ( )



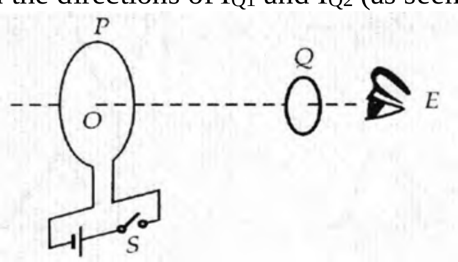
(a) Zero (b) infinity (c) data insufficient (d) none of these

14. The planes of two circular conductors are perpendicular to each other as shown in figure. If the current in conductor B is changed, the induced current in conductor A will be ( )



(a) Increasing (b) decreasing (c) zero (d) infinity

15. P and Q are two coaxial conducting loops separated by some distance. When the switch S is closed, a clockwise current I_p flows in P (as seen by E) and an induced current I_{Q1}flows in Q. The switch remains closed for a long time. When S is opened, a current I_{Q2} flows in Q. Then the directions of I_{Q1} and I_{Q2} (as seen by E) are ( )



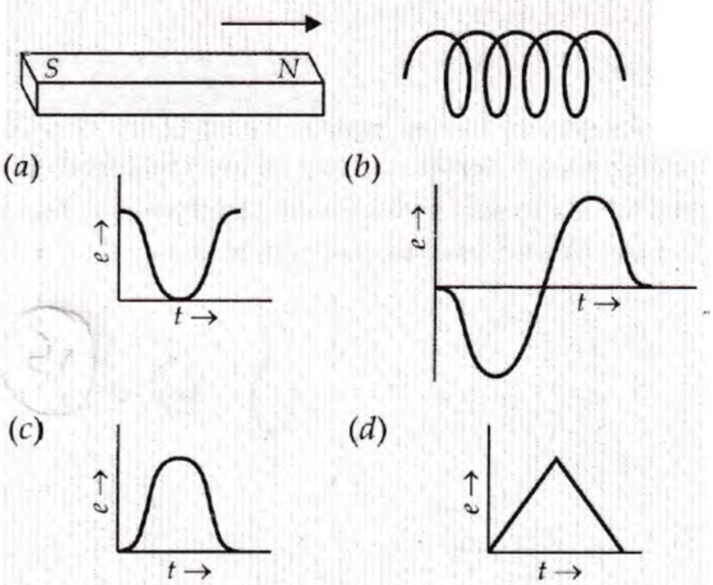
(a) Both clockwise
(b) Both anticlockwise
(c) Respectively clockwise and anticlockwise

(d) Respectively anticlockwise and clockwise

16. An infinitely long cylinder is kept parallel to a uniform magnetic field B directed along positive Z – axis. The direction of induced current as seen from the Z – axis will be ( )
    (a) Clockwise of the positive Z – axis
    (b) Anticlockwise of the positive Z – axis
    (c) Zero
    (d) Along the magnetic field

17. A thin circular ring of area A is held perpendicular to a uniform field of induction B. A small cut is made in the ring and a galvanometer is connected across the ends such that the total resistance of the circuit is R. When the ring is suddenly squeezed to zero area, the charge flowing through the galvanometer is ( )
    (a) $\frac{BR}{A}$ (b) $\frac{AB}{R}$ (c) ABR (d) $\frac{B^2A}{R^2}$

18. The variation of induced e.m.f. (e) with time (t) in a coil, if a short bar magnet is moved along its axis with a constant velocity is best represented as ( )

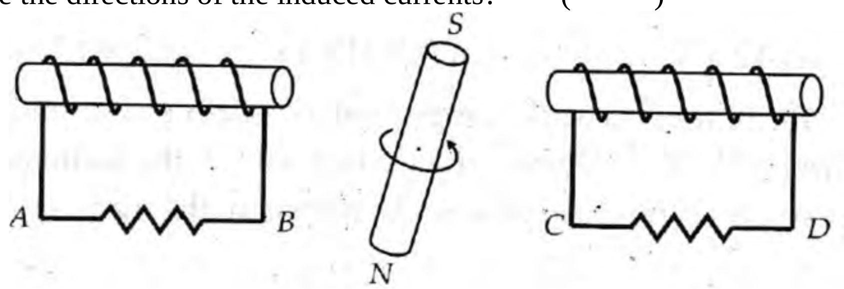


19. A coil having ‘n’ turns and resistance R Ω is connected with a galvanometer of resistance 4RΩ. This combination is moved in time‘t’ seconds from a magnetic flux φ_1 weber to φ_2 weber. The induced current in the circuit is ( )

    (a) $\frac{\phi_2 - \phi_1}{5Rnt}$ (b) $-\frac{n(\phi_2 - \phi_1)}{5Rt}$

    (c) $-\frac{(\phi_2 - \phi_1)}{Rnt}$ (d) $-\frac{n(\phi_2 - \phi_1)}{Rt}$

20. Lenz’s law applies to ( )
(a) Electrostatics (b) lenses (c) electromagnetic induction (d) cinema slides
21. A coil having 500 square loops of side 10 cm is placed normal to magnetic flux which increases at a rate of 1 T/s. The induced e.m.f. is ( )
(a) 0.1 V (b) 0.5 V (c) 1.0 V (d) 5.0 V
22. A conducting circular loop is placed in a uniform magnetic field of induction B tesla with its plane normal to the field. Now, the radius of the loop starts shrinking at the rate [dr/dt]. Then the induced e.m.f. at the instant when the radius is ‘r’, is ( )
(a) $\pi r B[dr/dt]$ (b) $2\pi r B[dr/dt]$ (c) $\pi r^2[dB/dt]$ (d) $2\pi r[dr/dt]$
23. The magnetic flux linked with a coil (in Wb) is given by the equation:
$\varphi = 5t^2 + 3t + 16$
The induced e.m.f. in the coil in the fourth second will be ( )
(a) 10V (b) 108V (c) 145V (d) 210V
24. The S.I. unit of magnetic flux is ( )
(a) Tesla (b) Oersted (c) Weber (d) Gauss
25. A moving conductor coil produces an induced e.m.f. This is in accordance with ( )
(a) Lenz’s (b) coulomb’s law (c) Faraday’s law (d) Ampere’s law
26. The dimensional formula for e.m.f $\mathcal{E}$ in M.K.S. system will be ( )
(a) $[ML^2T^{-2}Q^{-1}]$ (b) $[ML^2T^{-1}]$ (c) $[ML^{-2}Q^{-1}]$ (d) $[MLT^{-2}Q^{-2}]$
27. The magnet in figure rotates as shown on a pivot through its centre. At the instant shown, what are the directions of the induced currents? ( )



(a) A to B and C to D
(b) B to A and C to D
(c) A to B and D to C
(d) B to A and D to C
28. Suppose the number of turns in a coil be tripled, the value of magnetic flux linked with it ( )
(a) Remains unchanged (b) becomes 1/3 (c) is tripled (d) none of these
29. A square loop of wire of each side 50 cm is kept, so that its plane makes an angle ‘θ’ with a uniform magnetic field of induction 1T. The magnetic field is withdrawn in 0.1 sec., It is found that the induced e.m.f. across the loop is 125mV. The angle ‘θ’ is ( )
(a) 90^0 (b) 60^0 (c) 45^0 (d) 30^0

30. A thin ring of radius 'R' metre has charge 'q' coulomb uniformly spread on it. The ring rotates about its axis with a constant frequency of 'f' revolutions per second. The value of magnetic induction in Wb/m^2 at the centre of the ring is ( )

(a) $\frac{\mu_0 q f}{2\pi R}$ (b) $\frac{\mu_0 q}{2\pi f R}$ (c) $\frac{\mu_0 q}{2 f R}$ (d) $\frac{\mu_0 q f}{2R}$

31. A magnetic field 2×10^{-2} T acts at right angles to a coil of area 100 cm^2 with 50 turns. The average e.m.f. induced in the coil is 0.1V, when it is removed from the field in time't'. The value of 't' is

(a) 0.01 sec., (b) 0.5 sec., (c) 0.1 sec., (d) 1 sec., ( )

32. An aeroplane having a wing span of 35 m flies due north with a speed of 90 m/s, given B = 4×10^{-5} T. The potential difference between the tips of the wings will be ( )

(a) 0.126V (b) 1.26V (c) 12.6V (d) 0.013V

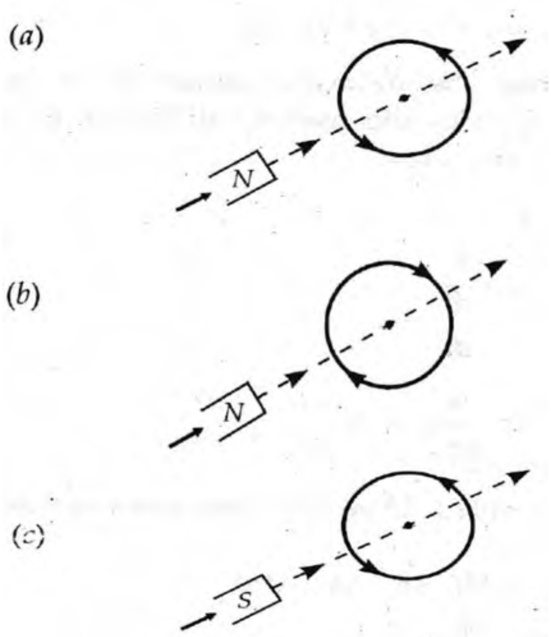
33. A conducting circular loop is placed in a uniform magnetic field, B = 0.025T with its plane perpendicular to the loop. The radius of the loop is made to shrink at a constant rate of 1mm/s. The induced e.m.f. when the radius is 2 cm, ( )

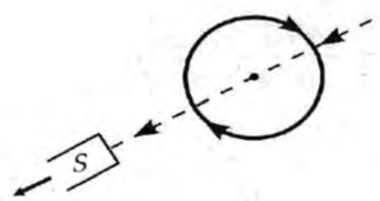
(a) $2\pi\mu V$ (b) $\pi\mu V$ (c) $3\pi\mu V$ (d) $2\mu V$

34. A metal ring is held horizontally and bar magnet is dropped through the ring with its length along the axis of the ring. The acceleration of the falling magnet is ( )

(a) Equal to g (b) less than g (c) more than g (d) either (a) or (c)

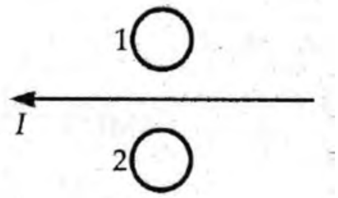
35. Which of the following figures correctly depicts the Lenz's law? The arrow show the movement of the labelled pole of a bar magnet into a closed circular loop and the arrows on the circle show the direction of the induced current. ( )



(d) 

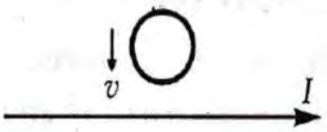
36. A wire loop is rotated in a magnetic field. The frequency of change of direction of the induced e.m.f. is ( )
(a) Once per revolution
(b) Twice per revolution
(c) Four times per revolution
(d) Six times per revolution

37. The direction of induced current in metal rings 1 and 2 when current I in the wire is steadily decreasing as shown in figure, is ( )



(a) Anticlockwise in both the rings
(b) Clockwise in both the rings
(c) Anticlockwise in ring 1 and clockwise in ring 2
(d) Clockwise in ring 1 and anticlockwise in ring 2

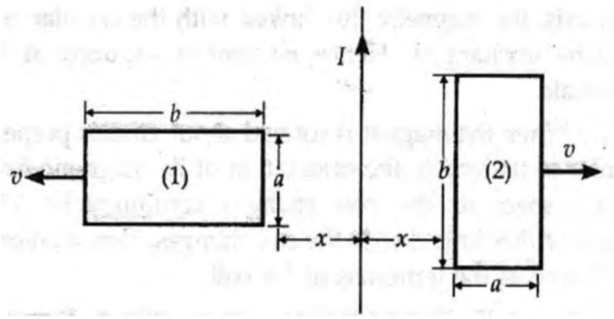
38. What is the direction of induced current in a metal ring when the ring is moved towards a straight conductor with constant speed v? The conductor is carrying current I in the direction shown in figure. ( )



(a) No induced current develops in metal ring
(b) Anticlockwise direction
(c) Clockwise direction
(d) None of the above

39. The dimensional formula of magnetic flux (φ) is ( )
(a) $[ML^2A^{-1}T^{-2}]$ (b) $[MLA^{-1}T^{-2}]$ (c) $[ML^2AT^{-2}]$ (d) $[ML^2A^{-1}T^{-1}]$

40. Figure shows two identical rectangular loops (1) and (2), placed on a table along with a straight long current carrying conductor between them. The directions of the induced currents in the loops when they are pulled away from the conductor with same velocity v is ( )



(a) Anticlockwise in both the loops
(b) Clockwise in both the loops
(c) Anticlockwise in loop 1 and clockwise in loop 2
(d) Clockwise in loop 1 and anticlockwise in loop 2.

41. An inductor coil of inductance L is divided into two equal parts and both parts are connected in parallel. The net inductance is :

(A) L

(B) 2L

(C) L/2

(D) L/4

42. An e.m.f. of 5 millivolt is induced in a coil when in a nearby placed another coil, the current changes by 5 ampere in 0.1 second. The coefficient of mutual induction between the two coils will be :

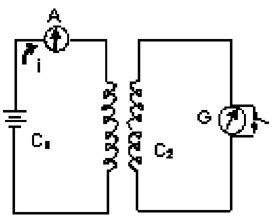
(A) 1 Henry

(B) 0.1 Henry

(C) 0.1 millihenry

(D) 0.001 millihenry

43. In figure when key is pressed the ammeter A reads i ampere. The charge passing in the galvanometer circuit of total resistance R is Q. The mutual inductance of the two coils is :



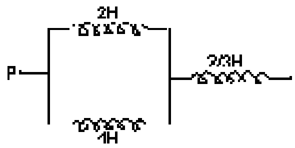
(A) Q/R

(B) QR

(C) QR/i

(D) i/QR

44. The equivalent inductance between points P and Q in figure is :



(A) 2 H

(B) 6 H

(C) 8/3 H

(D) 4/9 H

45. A metal disc of radius R rotates with an angular velocity ω about an axis perpendicular to its plane passing through its centre in a magnetic field of induction B acting perpendicular to the plane of the disc. The induced e.m.f. between the rim and axis of the disc is:

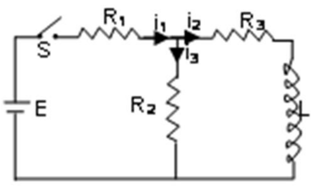
(A) $B\pi R^2$

(B) $2B\pi^2R^2/\omega$

(C) $B\pi R^2\omega$

(D) $BR^2\omega/2$

46. In the circuit shown in the adjoining diagram E = 10 volts, R_1 = 2 ohms, R_2 = 3 ohms, R_3 = 6 ohms and L = 5 henry. The current i_1 just after pressing the switch S is :



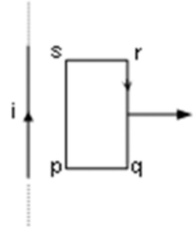
(A) 2.5 amp

(B) 2 amp

(C) 5/6 amp

(D) 5/3 amp

47. A rectangular coil pqrs is moved away from an infinite, straight wire carrying a current as shown in figure. Which of the following statements is correct?



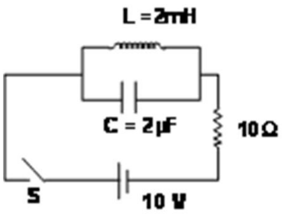
(A) There is no induced current in coil pqrs

(B) The induced current in coil pqrs is in the clockwise sense

(C) The induced current in the coil pqrs is in anticlockwise direction

(D) None of the above

48. The switch S is closed in the circuit shown at time t = 0. The current in the resistor at t = 0 and t = ∞ are respectively.



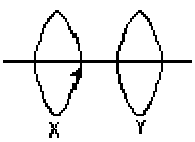
(A) 0, 0 Amp.

(B) 1, 0 Amp.

(C) 0, 1 Amp.

(D) 1, 1 Amp.

49. The two loops shown in the figure, have their planes parallel to each other. A clockwise current flows in the loop X as viewed from X towards Y. The two coils will repel each other, if the current in the loop X is :



(A) increasing

(B) decreasing

(C) constant

(D) none of the above cases

50. A coil of area 500 cm^2 having 1000 turns is placed such that the plane of the coil is perpendicular to a magnetic field of magnitude 4×10^{-5} weber/m^2. If it is rotated by 180° about an axis passing through one of its diameter in 0.1 sec, find the average induced emf.

(A) zero.

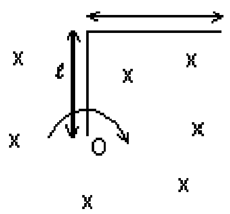
(B) 30 mV

(C) 40 mV

(D) 50 mV

Medium Level

51. For the L shaped conductor in a uniform magnetic field B shown in figure, the emf across its ends when it rotates with angular velocity 'ω' about an axis through one of its ends O and normal to its plane will be



(A) 2 $B\omega l^2$

(B) $B\omega l^2$

(C) (1/2) $B\omega l^2$

(D) 4 $B\omega l^2$

52. A coil of inductance 8.4 mh and resistance 6 Ω is connected to a 12 V battery. The current in the coil is 1.0 A approximately after time

(A) 500 ms

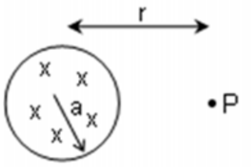
(B) 20 s

(C) 35 ms

(D) 1 ms

53. A uniform but time-varying magnetic field B(t) exists in a circular region of radius a and is directed into the plane of the paper, as shown. The magnitude of the induced electric

field at point P at a distance r from the centre of the circular region is



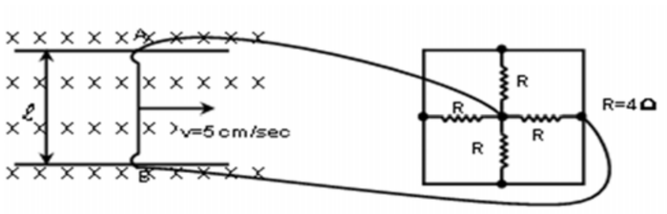
(A) is zero

(B) proportional to r

(C) proportional to 1/ r

(D) proportional to $1/r^2$

54. A conductor of length 5 cm, and resistance 2Ω is moving on frictionless rails with a constant velocity of 5 cm/s in a magnetic field of intensity 3 tesla as shown below. If conductor is connected to a circuit as shown, by two lead wires of almost negligible resistance, then current flowing in it is



(A) 0.25 A

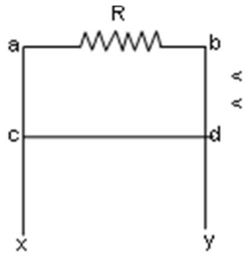
(B) 2.5 Amp

(C) 2.5 mA

(D) 0.25×10^4 amp

55. A wire cd of length l , mass m, is sliding without friction on conducting rails ax and by as shown in figure. The vertical rails are connected to one another via an external resistance R. The entire circuit is placed in a region of space having a uniform magnetic field B.

The field is ⊥ to the plane of circuit & directed outwards. The steady speed of rod cd is



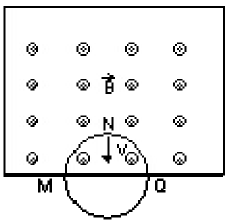
(A) mg R/Bl

(B) mg R/B^2l^2

(C) mg R/Bl^2

(D) mg R/B^2l

56. A thin circular-conducting ring having N turns of radius R is falling with its plane vertical in a horizontal magnetic field B. At the position MNQ, the speed of ring is v, the induced e.m.f. developed across the ring is



(A) Zero

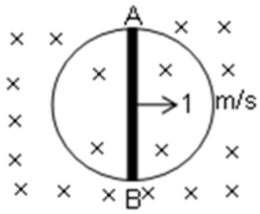
(B) $BV\pi R^2N/2$ and M is at higher potential

(C) N πBRv and Q is at higher potential

(D) 2RBvN and Q is at lower potential

57. A circular loop of radius 1m is kept in a magnetic field of strength 2 T directed perpendicular to the plane of loop. Resistance of the loop wire is $2/\pi$ Ω/m. A conductor of length 2 m is sliding with a speed 1 m/s as shown in the figure. Find the instantaneous

force acting on the rod [Assume that the rod has negligible resistance]



(A) 8 N

(B) 16 N

(C) 32 N

(D) 64 N

58. Two coils A and B have 200 and 400 turns respectively. A current of 1 A in coil A causes a flux per turn of 10^{-3} Wb to link with A and a flux per turn of 0.8×10^{-3} Wb through B. The ratio of self-inductance of A and the mutual inductance of A and B is :

(A) 5/4

(B) 1/1.6

(C) 1.6

(D) 1

59. A uniform conducting rod of mass M and length l oscillates in a vertical plane about a fixed horizontal axis passing through its one end with angular amplitude θ . There exists a constant and uniform horizontal magnetic field of induction B perpendicular to the plane of oscillation. The maximum e.m.f. induced in the rod is

(A) $\frac{B}{8}\sqrt{27\ell^3 g(1-\cos\theta)}$

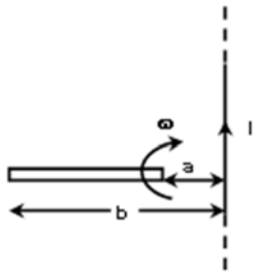
(B) $\frac{B}{8}\sqrt{27\ell^3 g(1+\cos\theta)}$

(C) $B\sqrt{\frac{3\ell^3 g(1-\cos\theta)}{4}}$

(D) $B\sqrt{\frac{3\ell^3 g(1+\cos\theta)}{4}}$

60. A copper rod moves with a constant angular velocity ω , about a long straight wire carrying a current I. If the ends of the rod from the wire are at distances a and b, then the

e.m.f. induced in the rod is



(A) $\frac{\mu_0 i(wa)}{2\pi}\ln\left(\frac{b}{a}\right)$

(B) $\frac{\mu_0 i(wb)}{2\pi}\ln\left(\frac{b}{a}\right)$

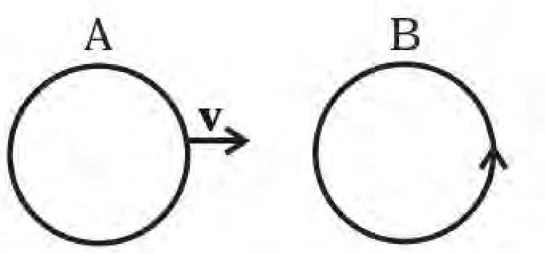
(C) zero

(D) $\frac{\mu_0 iw(a+b)}{4\pi}\ln\left(\frac{b}{a}\right)$

HOTS

61. There are two coils *A* and *B* as shown in figure. *A* current starts flowing in *B* as shown, when *A* is moved towards *B* and stops when *A* stops moving. The current in *A* is counter clockwise. *B* is kept stationary when *A* moves. We can infer that
(a) there is a constant current in the clockwise direction in A

(b) there is a varying current in *A*
(c) there is no current in *A*
(d) there is a constant current in the counter clockwise direction in *A*



62. The self inductance *L* of a solenoid of length *l* and area of cross-section *A*, with a fixed number of turns *N*, increases as
(a) *l* and *A* increase

(b) *l* decreases and *A* increases
(c) *l* increases and *A* decreases
(d) both *l* and *A* decrease

63. A metal plate is getting heated. It can be because
(a) a direct current is passing through the plate

(b) it is placed in a time varying magnetic field

(c) it is placed in a space varying magnetic field, but does not vary with time

(d) a current (either direct or alternating) is passing through the plate

64. An emf is produced in a coil, which is not connected to an external voltage source. This can be due to
(a) the coil being in a time varying magnetic field

(b) the coil moving in a time varying magnetic field

(c) the coil moving in a constant magnetic field

(d) the coil is stationary in external spatially varying magnetic field, which does not change with time

65. The mutual inductance M_{12} of coil 1 with respect to coil 2
(a) increases when they are brought nearer

(b) depends on the current passing through the coils

(c) increases when one of them is rotated about an axis

(d) is the same as M_{21} of coil 2 with respect to coil 1

66. A circular coil expands radially in a region of magnetic field and no electromotive force is produced in the coil. This can be because

(a) the magnetic field is constant
(b) the magnetic field is in the same plane as the circular coil and it may or may not vary
(c) the magnetic field has a perpendicular (to the plane of the coil) component whose magnitude is decreasing suitably
(d) there is a constant magnetic field in the perpendicular (to the plane of the coil) direction

VSA-1 MARKS

67. A solenoid with an iron core and a bulb is connected to a dc source . how does the brightness of the bulb change , when the iron core is removed from the solenoid?
68. The coils , in certain Galvanomters , have a fixed core made of a non - magnetic metallic material . why dose the oscillatory coil come to rest so quickly in such a core ?
69. Two identical loops , one of Cu and another of constanton are removed from a magnetic field with in the same time interval . In which loop the induced current be greater?
70. Mention any one useful application of eddy currents.
71. A solenoid with an iron core and a bulb is connected to a dc source . how does the brightness of the bulb change , when the iron core is removed from the solenoid?

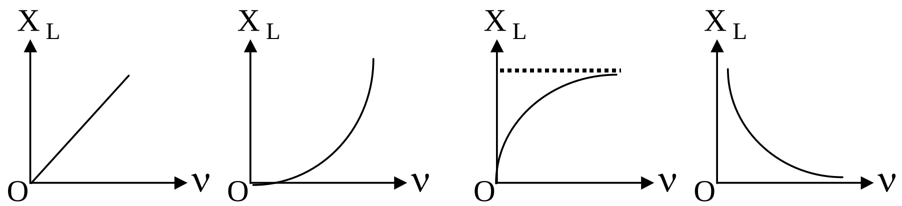
ALTERNATING CURRENTS

1. A steady potential difference of 10 V produces heat at a rate x in a resistor. The peak value of the alternating voltage which will produce heat at a rate x/2 in the same resistor is

   1) 5 V 2) $5\sqrt{2}$ V
   3) 10 V 4) $10\sqrt{2}$ V

2. Which one of the following represents the variation of inductive reactance (X_L) with the frequency of the voltage source?

1) 2) 3) 4)



3. An inductive coil has a resistance of 100ohm. When an ac signal of frequency 1000 Hz is applied to the coil, the voltage leads the current by 45^0. The inductance of the coil is

1) $1/10\pi$ 2) $1/20\pi$ 3) $1/40\pi$ 4) $1/60\pi$

4. In an ac circuit V(in volt) = 100 sin (100t) and I(in mA) = 100 sin(100t+ π/3) . The power dissipated in the circuit is

   1) 10^4 W 2) 10 W
   3) 2.5 W 4) 5 W

5. An inductor may store energy in
   1) its electric field 2) its coils
   3) its magnetic field 4) both in electric and magnetic fields
6. An LCR series circuit consists a resistance of 10ohm, a capacitance of reactance 60ohm and an inductor coil. The circuit is found to resonate when put across a 300 V, 100 Hz supply. The inductance of the coil is (Take $\pi = 3$)
   1) 0.1 H 2) 0.01 H
   3) 0.2 H 4) 0.02 H
7. In above problem, the current in the circuit at resonance is
   1) 10 A 2) 15 A 3) 30 A 4) 60 A
8. An alternating emf given by $V = V_0 \sin(\omega t)$ has peak value 10 V and frequency 50 Hz. The instantaaneous emf at t = 1/600 s is

1) 10 V 2) $5\sqrt{3}$ V 3) 5 V 4) 1 V

9. A resistance R, an inductance L and a capacitance C are connected in series across an ac source of angular frequency ω. If the resonant frequency is ω_0, then the current will lag behind the voltage if

1) $\omega < \omega_0$ 2) $\omega > \omega_0$
3) $\omega = \omega_0$ 4) $\omega = 0$

10. A.C. power is transmitted from a power house at a high voltage as

1) the rate transmission is faster at high voltages
2) it is more economical due to less power loss
3) power cannot be transmitted at low voltages
4) a precaution against theft of transmission lines

11. In an ac circuit, the rms value of the current, I_{rms}, is related to the peak current I_0 as

1) $I_{rms} = I_0/\pi$ 2) $I_{rms} = I_0/\sqrt{2}$
3) $I_{rms} = \pi I_0$ 4) $I_{rms} = \sqrt{2}I_0$

12. The impedance of circuit consists of 3ohm resistance and 4ohm reactance. The power factor of the circuit is

1) 0.4 2) 0.6 3) 0.8 4) 1.0

13. In an LCR series circuit, the capacitance is changed from C to 4C. For the same resonant frequency, the inductance should be changed from L to

1) 2L 2)L/2 3) L/4 4) 4L

14. An inductor of 1 H is connected across a 220 V, 50 Hz supply. The peak value of the current is approximately

1) 0.5 A 2) 0.7 A 3) 1 A 4) 1.4 A

15. When a direct current I is passed through an inductance L, the energy stored is

1) Zero 2) LI 3) $(1/2)LI^2$ 4)$L^2/2I$

16. When 100 V dc is applied across a coil, a current of 1 A flows through it. When 100 V ac of 50 Hz is applied across the same coil, only 0.5 A flows. The resistance and inductance of the coil are (Take $\pi^2 = 10$)

1) 50ohm, 0.3H 2) 50ohm, $\sqrt{0.3}$ H 3) 100ohm, 0.3 H 4) 100ohm, $\sqrt{0.3}$ H

17. The inductive rectance of a coil of 0.2 H inductance in ohm at a frequncy of 60 Hz is

1) 7.54 2) 0.754 3) 75.4 4) 7.54×10^{-3}

18. The effective value of an alternating current is 5 A. The current passes through 24 Ω resistor. The maximum potential difference across the resistor is

1) 10 V 2) 17 V 3) 170 V 4) 1700 V

19. A 20 volt a.c. is applied to a circuit consisting of a resistance and a coil with negligible resistance. If the voltage across the resistance is 12 volt, the voltage across the coil is

1) 16 volt 2) 10 volt 3) 8 volt 4) 6 volt.

20. An alternating voltage, E (in volt) = 220 sin 100 t is connected to one microfarad capacitor through an a.c. ammeter. The reading of the ammeter shall be

1) 10 mA 2) $11\sqrt{2}$ mA 3) 40 mA 4) 80 mA

21. In a purely resistive A.C. circuit, the current

1) lags behinds the .em.f. in phase

2) is in phase with e.m.f.
3) leads the e.m.f in phase
4) leads the e.m.f. inhalf the cycle and lags behind it in the other half.

22. A generator produces a voltage that is given by V = 240 sin 120t volt, where t is in second. The frequency and r.m.s voltage are
1) 60 Hz. & 240 votl 2) 19Hz. & 120 volt
3) 19 Hz. & 170 volt 4) 754 Hz. & 170 volt.
23. The maximum value of a.c. in a circuit is 707 V. Its virtual value is
1) 70.7 V 2) 100 V 3) 500 V 4) 707 V
24. In an LCR circuit, inductance is changed from L to L/2. To keep the same resonance frequency, C should be changed to
1) 2C 2) C/2 3) 4C 4) C/4
25. The angular frequency of a.c. at which a coil of inductance 1mH has a reactance of 1ohm is
1) 10^3 2) 10 3) 10^{-3} 4) 1
26. Reactance a capacitor of 1/π farad at 50 Hz is
1) 100 2) 10 3) 50 4) 10^{-2}
27. The p.d across a cirucit element can be greater than the source e.m.f in
1) d.c. circuit only 2) a.c. circuit only
3) both d.c. and a.c circuits 4) neither of the two
28. An a.c. ammeter connected in series in an a.c. circuit reads 5 ampere. The peak value of current is
1) 5 A 2) $5/\sqrt{2}$ A 3)$5\sqrt{2}$ A 4) 10/π A
29. An a.c. circuit contains 4 ohm resistance in series with an inductance coil of reactance 3. The impedance of the circuit is
1) 7 2) 5 3) 1 4) (4/3)
30. An electric bulb of 100 watt is connected in parallel with an ideal inductance of 1 H. This arrangement is connected to 90 volt battery through a switch. On pressing the switch.
1) bulb glows
2) bulb glows after short time and then continues to glow
3) bulb does not glow
4) bulb glows for a short time and then stops glowing.
31. In a circuit containing an inductance of zero resistance, the current leads the applied a.c. voltage by a phase angle of
1) 90^0 2) -90^0 3) 0^0 4) 180^0
32. The current passing through a choke coil of 5 henry is decreasing at the rate of 2 amp./sec. The e.m.f. develolped across the coil is
1) 10 V 2) -10 V 3) 2.5 V 4) -2.5 V
33. The resonant frequency of a circuit of negligible resistance containing one inductance of 50 mH and a capacitance of 500 pf is
1) $10^5/\pi$ 2) 1/π 3) 100/π 4) 1000/π
34. The instantaneous current in a circuit is given by I = 2 cos (ωt+ϕ) ampere. The r.m.s value of the current is
1) zero 2) $\sqrt{2}$A 3) 2 A 4)$2\sqrt{2}$A

35. Alternating voltage V = 400 sin (500 t) is applied across a resistance of 0.2k. The r.m.s.value of current will be equal to
1) 14.14 A 2) 1.414 A 3) 0.1414 A 4) 2.0 A

36. The equation of alternating current is given by E = 158 sin 200 πt. The value of voltage at time t = 1/400 sec is
1) -158 V 2) -79 V 3) 79 V 4) 158 V

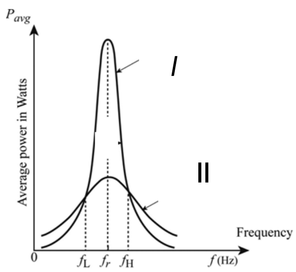
37. The instantaneous values of current and voltage in an A.C. circuit are respectively I=4sin(ωt) and E = 100 cos (ωt+π/3) . The phase difference between voltage and current is
1) 7 π /t 2) 6 π /5 3) 5 π /6 4) π /3

38. Current in a circuit can be wattless, if
1) current is alternating
2) resistance in circuit is zero
3) inductance in circuit is zero
4) resistance and inductance both are zero

39. The frequency of AC is 50Hz, minimum how many times the current becomes zero in one second?
1) 50 times 2) 100 times 3) 200 times 4) 25 times

40. A voltmeter reads V volt in an AC. Circuit. Then V is
1) Peak value of voltage
2) Peak value of current
3) r.m.s value of current
4) r.m.s. value of voltage

41	The equations for current and voltage across a resistor when an AC is applied across a resistor are a. $v = vmsin\omega t, i = im\ sin\omega t$ b. $v = vmsin\omega t, i = im\ cos\omega t$ c. $v = vmcos\omega t, i = im\ sin\omega t$ d. $v = vmsin\omega t, i = im\ \cos(\omega t$-ø)
42	A light bulb is rated at 100w for a 220 V supply. Then the resistance of the bulb, the peak voltage of the source and the rms current through the bulb are a. 484Ω, 311 V, 0.450A b. 300Ω, 411 V, 0.350A c. 484Ω, 311 V, 0.650A d. 300 Ω,211V,0.450A
43	What is the power dissipation in an ac circuit in which voltage and current are given by $v = 3000\sin(\omega t - \frac{\pi}{2})$ and $= 10\ sin\omega t$? a. 1 b. 0.5 c. 0

	d. 2
44	11 kw of electric power can be transmitted to a distant station at (i) 220V or (ii) 22000V. Which of the two modes of transmission should be preferred and why? a. 220V b. 22000V c. Both d. none of the two
45	From the following find the condition of Resonance in an LCR series circuit between the current and voltage. a. $XL = XC$, Current is in phase with voltage b. $XL > XC$, Current is out of phase in Voltage c. $XL < XC$ Current is in phase with voltage d. $No\ relationship\ between\ XL\ and XC$ but current is in phase with voltage
46	A light bulb is rated 100 W for 220 V ac supply of 50 Hz. The resistance of the bulb and the rms current through the bulb are a. 400Ω,0.5A b. 400Ω,0.2A c. 484Ω,0.45A d. 300Ω,0.5A
47	The current is drawn by the primary of a transformer which steps down 220V to 22V to operate device with impedance of 220 ohm is a. 0.1 A b. 0.01A c. 0.001A d. 0.0001A
48	A series LCR circuit with L=0.405H, C-=25μF, R= 0Ω is connected to a variable frequency1supply. The frequency at which the current is maximum is a. 314 rad/s b. 450 rad/s c. 220rad/s d. 0 rad/s
49	From the figure the curve with highest value of Q-factor is a. Curve I b. Curve II c. Both the curves d. None of them 

50	The type of transformer for which the transformation ratio K<1 is called , and the transformation ratio is a. Step up transformer, $\frac{ip}{is}$ b. Step down transformer, $\frac{ip}{is}$ c. Step up transformer,$\frac{vp}{vs}$ d. Step down transformer,$\frac{vp}{vs}$
51	The circuit which has the resonance condition from the following are a. LCR series circuit, LR circuit b. LR & CR circuits c. CR & LCR series circuits d. LCR circuit only.
52	The principle involved in the working of an AC generator is a. Electromagnetic Induction b. Self Induction c. Mutual Induction d. None of the above
53	IN case of LCR series circuit, at resonance the circuit is ____________ in nature and the phase difference between the voltage and current is ______ a. Capacitive, 0◦ b. Resistive , 0◦ c. Inductive , 0◦ d. Inductive , 90◦
54	In an LCR series circuit the expression for finding the phase angle is______. For the circuit to be capacitive in nature the phase angle should be ____________. a. $\emptyset=\tan^{-1}(\frac{Xc-XL}{R})$, Positive b. $\emptyset=\sin^{-1}(\frac{Xc-XL}{R})$, negative c. $\emptyset=\cos^{-1}(\frac{Xc-XL}{R})$,0◦ d. $\emptyset=\tan^{-1}(\frac{Xc-XL}{R})$,0◦
55	The expression for resonant frequency for an LCR series circuit is___________. The current in the circuit is ___________ at resonance. a. $\omega = \frac{1}{\sqrt{LC}}$,maximum b. $\omega = \frac{1}{\sqrt{LC}}$, minimum c. $\omega = \frac{1}{\sqrt{LC}}$,zero d. $\omega = \frac{1}{\sqrt{LC\ R}}$,zero

56	At an airport, a person is made to walk through the doorway of a metal detector, for surety reasons. If she/he is carrying anything made of metal, the metal detector emits a sound .The principle on which this metal detector work is____________. a. Electromagnetic Induction b. Resonance in ac circuits c. Current carrying conductor placed in a magnetic field experiences torque d. Potential gradient is constant
57	The expression for Q- factor of an LCR circuit and the method to improve the Q-factor of an LCR circuit is _____________. a. $\frac{R}{\omega rL}$, decreasing L b. $\frac{\omega rL}{R}$,decreasing R c. $\frac{\omega rC}{R}$, decreasing C d. $\frac{\omega rC}{R}$, increasing C
58	The Si unit of ωL and $\frac{1}{\omega C}$ is a. Micro farad b. Henry c. Ohm d. Volt.
59	The dimensional formula of *LC* is a. $[M^1L^0T^{2]}$ b. $[M^1L^1T^{2]}$ c. $[M^1L^0T^{3]}$ d. $[M^0L^0T^{2]}$
60	The phase difference between voltage drop across *L* and *C* in a series LCR circuit connected to an ac source is ______ a. 0◦ b. 90◦ c.180◦ d. 360◦
61	In a transformer, there are tow coils placed near one another. First has 100 turns and 1 A current and the other 25 turns. Current flowing though it will be (a) 1A (b) 4A (c) 16A (d) 1/16 A
62	A device which converts mechanical energy into electrical energy is a. Electric Motor b. Transformer c. AC generator d. Induction coil

63	The ratio of secondary to primary turns is 9:4. If power input is P, what will be the ratio of power output to power input? (a). 4:9 (b) 9:4 (c) 5:4 (d) 1:1
64	In an LCR series circuit, the voltage across each of the components L,C and R is 50 V. The voltage across the LC combination will be (a) 50 V (b) $50\sqrt{2}$ V (c) 100 V (d) 0V
65	In an LCR circuit, capacitance is changed from C to 2C. For the resonant frequency to remain unchanged, the inductance should be changed from L to (a) 4L (b) 2L (c) L/2 (d) L/4

<u>Objective type questions</u>

66	What is the average value of alternating emf over one cycle?
67	Can we control alternating current with the help of a capacitor?
68	What is the maximum and minimum value of power factor?
69	Which value of current do you measure with an ac ammeter?
70	What is the power disspated in an ac circuit in which voltage and current are given by V=$230\sin\left(\omega t+\frac{\pi}{2}\right)$ and $I = 10\ sin\omega t$?
71	What are the factors on which the power factor depends?
72	If the frequency of ac source is in LCR series circuit is increased, how does the current in the circuit change?
73	What is the importance of power factor?.
74	Whys is the core of a transformer made of a magnetic material of high permeability?.
75	What causes the core of a transformer to get heated up under operation?.
76	What is the principle of a transformer?
77	How can iron loss in a transformer be reduced?
78	The number of turns in secondary coil of a transformer is 100 times the number of turns in the primary coil. What is the transformation ratio?
79	The number of turns oin the secondary coil of a transformer is 500 times that in primary. What power is obtained from the secondary when power fed to the primary is 10 W?
80	Why is soft iron used to make the core of a transformer?
81	What is iron loss in a transformer?
82	How are the energy losses reduced in transformer?
83	Give the expression for the induced emf set up in a coil rotating in a uniform magnetic field.

84	An ac voltage of 200V is applied to the primary of a transformer and voltage of 2000 V is obtained from the secondary. Calculate the ratio of the currents through the primary and secondary coils.
85	What is the Q- value of a LCR series circuit with L=2.0H, C= 32μF and R= 10Ω?

RAY OPTICS

1 If a glass rod is immersed in a liquid of the same refractive index, then it will_______________.

(A) appear bent (B) appear longer

(C) disappear (D) appear shorter

2 The velocity of light is maximum in a medium of_________________.

(A) diamond (B) water

(C) glass (D) vaccum

3 A convex lens forms a real image of an object for it s two different positons on a screen if hight of the image in both cases be 16 cm and 4 cm then height of the object is___________cm.

(A) –4 (B) 4

(C) –8 (D) 8

4 A glass slab n =1.5 of thikness 9 cm is placed over a written paper what is the Shift in the latters ?

(A) 6 cm (B) 3 cm

(C) 2 cm (D) 0 cm

5 A concave mirror has a focal langth 30 cm The distance between the two position of the object for which image size is double of the object is______________.

(A) 30 cm (B) 15 cm

(C) –25 cm (D) –15 cm

6 The Refractive Index of glass w r t air is 3 / 2 and Refractive Index of water w r t air is 4 / 3 then Refractive Index of glass w r t water is

(A) 8 / 9 (B) 9 / 8

(C) 72 (D) none

7 A Container filled with water 12.5 cm deep The depth of needle lying on the bottom of the container appears to be 9.4 cm The Refractive Index of water is

(A) 1.33 (B) 1,5

(C) 2,3 (D) none 12.5 / 9.4 = 1.33

8 Name the mirror whose focal length is Infinity Plane Mirror

(A) Concave mirror (B) Convex mirror

(C) Plane Mirror (D) none

9 What is the maximum lateral shift due to a glass Slab of thick ness t

(A) t (B) 2 t

(C) 3 t (D) none

10 A Concave mirror is placed in water , its focal length

(A) decreases (B) increases

(C) remains same (D) none

11 A mirror forms a real image of Unit magnification Its nature is

(A) Concave mirror (B) Convex mirror

(C) Plane Mirror (D) none

12 A lens behaves as converging lens in air and diverging lens in water What can be the Refractive Index of the lens

(A) equal to that of water (B) less than that of water

(C) greater than that of water (D) none

13 When a mono chromatic red light is used instead of blue light in a convex lens then its focal length will

(A) decreases (B) increases

(C) remains same (D) none

14 A Lens is placed in water , its focal length

(A) decreases (B) increases

(C) remains same (D) none

15 What is the ratio of velocities of two waves travelling in vacuum having wave lengths

4000 A^0 and 5000 A^0

(A) 1 : 1 (B) 1 : 2
(C) 4 : 5 (D) none

16 A concave refracting surface is one with a center of curvature:
(A) to the left of the surface
(B) to the right of the surface
(C) on the side of the incident light
(D) on the side of the refracted light

17 A concave spherical mirror has a focal length of 12 cm. If an object is placed 18 cm in front of it the image position is
(A) 7.2 cm behind the mirror
(B) 7.2 cm in front of the mirror
(C) 36 cm behind the mirror
(D) 36 cm in front of the mirror

18 A hollow lens is made of thin glass, as shown. It can be filled with air, water (n = 1.3) or CS2 (n = 1.6). The lens will diverge a beam of parallel light if it is filled with:
(A) air and immersed in air
(B) air and immersed in water
(C) water and immersed in CS2
(D) CS2 and immersed in water

19 An object is 30 cm in front of a converging lens of focal length 10 cm. The image is:
(A) real and larger than the object
(B) real and the same size than the object
(C) real and smaller than the object
(D) virtual and the same size than the object

20 A Convex lens of Refractive Index n_L is immersed in a medium of Refractive Index n_m How will it behave if n_L is less than n_m .

21 Arrange the Colours of Visible spectrum according to Critical angle

22 Why the Refractive Index in a transparent medium is greater than 1

23 Write the principle on which Optical fibre works

24 When light undergoes TIR what is the angle of deviation of the reflected ray

25 Find the velocity of light in Diamond given its Refractive Index is 2.4

26 What type of aberration do mirrors show

27 What is Principle of Reversibility

28 Name the factor which do not change when Light travels from one medium to another medium

29 At what distance the object must be placed before a concave mirror so that the Image will be same size of the object

30 What is the angle with which a Fish in the water can see the outer objects

31. The relation governing refraction of light from rarer to denser medium at a spherical refracting surface is

i) $-\frac{\mu 1}{u} + \frac{\mu 2}{v} = \frac{(\mu 2 - \mu 1)}{R}$

ii) $\frac{\mu 1}{u} - \frac{\mu 2}{v} = \frac{(\mu 2 - \mu 1)}{R}$

iii) $\frac{\mu 1}{u} + \frac{\mu 2}{v} = \frac{(\mu 2 - \mu 1)}{R}$

iv) None of these

32. One diopter is power of a lens of focal length

i) 1cm ii) 1m iii) -1cm iv) -1m

33. Which of the colour has maximum wavelength

i) Red ii) Violet iii) Yellow iv) Green

34. In vacuum, which colour travels fastest?

i) Red ii) Violet

iii) Yellow iv) All colours have the same velocity

35. When size of a scatterer is very much less than the wavelength (λ) of light, intensity of scattered light (I_s) varies as :

i) $I_s \ \alpha \ \frac{1}{\lambda}$ ii) $I_s \ \alpha \ \frac{1}{\lambda^2}$ iii) $I_s \ \alpha \ \frac{1}{\lambda^4}$ iv) Is $\alpha \ \frac{1}{\lambda^6}$

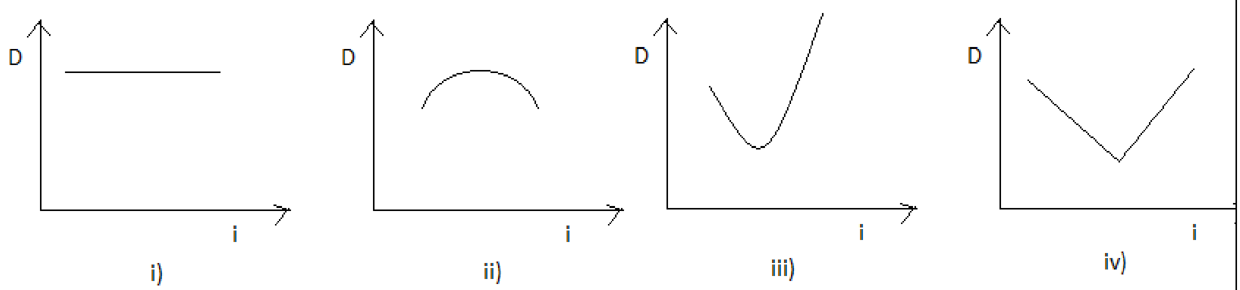
36. The relation between angle of incidence I, angle of prism A and angle of minimum deviation for a equilateral prism is

i) $i = A + \delta_m$ ii) $i = \frac{A+\delta_m}{2}$ iii) $\delta_m = i + A$ iv) $\delta_m = i - A$

37. The lens used for correcting myopia is

i) concave ii) convex iii) plano concave iv) none of these

38. The graph between angle of deviation (D) and angle of incidence (i) for a triangular prism is represented in the fig here by:



39. Magnification of -1 is obtained in which of the following case of lens

i) Object at focus of concave lens

ii) Object at 2F of convex lens

iii) Object at 2F of concave lens

iv) None of these

40. To make compound microscope following type of lenses are used

i) Concave lens for eye piece and convex lens for objective

ii) Concave lens for eye piece and concave lens for objective

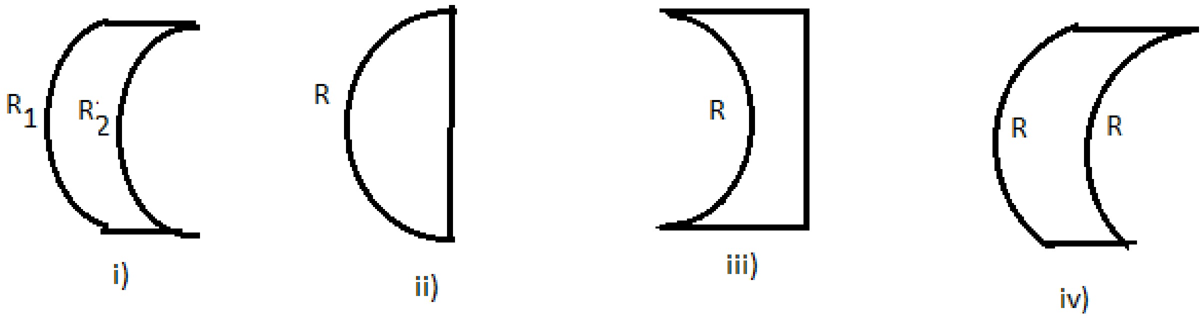
iii) Convex lens for eye piece and convex lens for objective

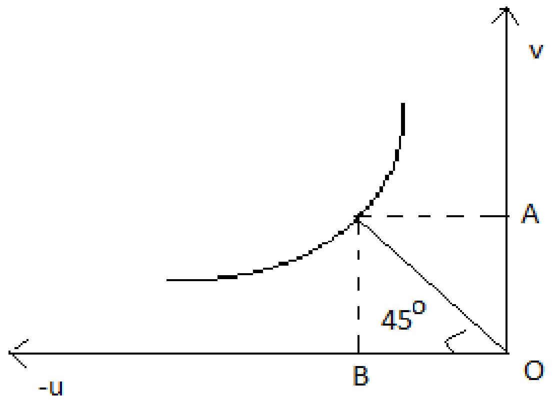
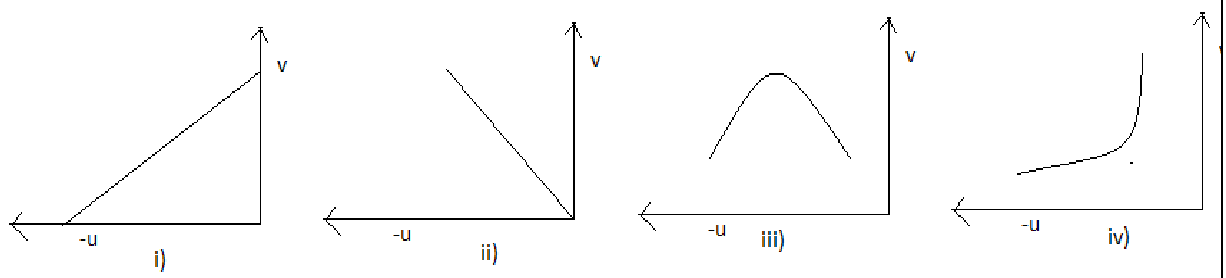
iv) Convex lens for eye piece and concave lens for objective

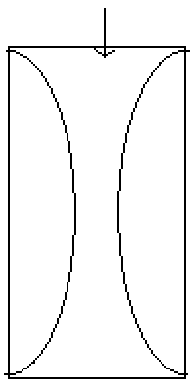
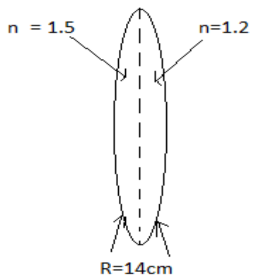
41. The final image in an astronomical telescope (w.r.t. object) is

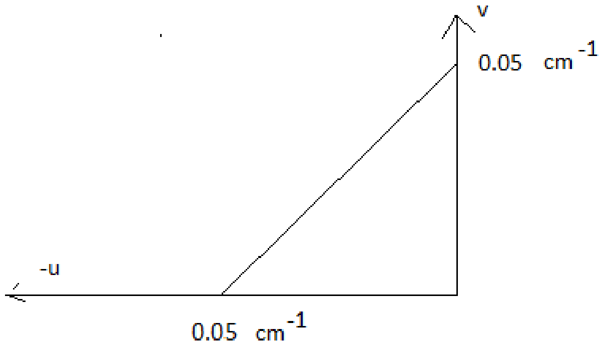
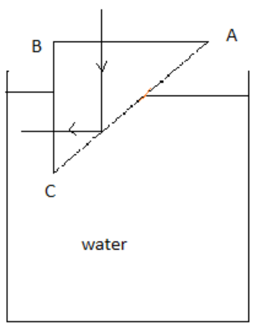
i)virtual & erect ii) real & erect iii) real & inverted iv) virtual & inverted

42. A telescope uses an objective lens of focal length fo and an eye lens of focal length fe. In normal adjustment , distance between the two lenses is

	i) fo/fe ii) fe/fo iii) fo-fe iv) fo+ fe
43.	The distance between an object and a divergent lens is m times the focal length of the lens. The linear magnification produced by the lens is i) m ii) 1/m iii) (m+1) iv) $\frac{1}{(m+1)}$
44.	The focal length of thin biconvex lens is 20cm. When an object is moved from distance of 25cm in front of it to 50cm, the magnification of its image changes from m_{25} to m_{50}. The ratio m_{25}/m_{50} is: i) 4 ii) 6 iii) 1 iv) 3
45.	A lens having focal length f and aperture of diameter d forms an image of intensity I. Aperture of diameter d/2 in central region of the lens is covered by a black paper. Focal length of the lens and intensity of image now will be respectively i) F and I/4 ii) 3f/4 and I/2 iii) f and 3I/4 iv) f/2 and I/2
46.	When monochromatic red light is used instead of blue light in a convex lens, its focal length will i) Increase iii) does not depend on colour of light ii) Decrease iv) remains same
47.	A biconvex lens has a radius of curvature of magnitude 20cm. Which one of the following options describes best the image formed of an object of height 2cm placed 30cm from the lens? i) Virtual, upright, height= 1cm iii) Virtual, upright, height = 0.5cm ii) Real, inverted, height = 4cm iv) Real, inverted, height = 1cm
48.	When a biconvex lens of glass having refractive index 1.47 is dipped in a liquid, it acts as a plane sheet of glass. This implies that the liquid must have refractive index i) Equal to that of sheet iii) greater than that of sheet ii) Less than one iv) less than that of glass
49.	Which of the following spherical lens does not exhibit dispersion? The radii of curvature of the surfaces of lenses are given in fig 
50.	A microscope is focused on a mark on a paper and then a slab of glass of thickness 3cm and refractive index 1.5 is placed over the mark. How should the microscope be moved to get the mark in focus again? i) 2cm upward ii) 1cm upward iii) 4.5cm upward iv) 1cm downward
51.	Following graph was obtained after measuring various u and v values for a convex lens. Find the focal length of the lens from graph

	 i) 2(OA) ii) OB/2 iii) OA+OB iv) OA/2
52.	Which of the following is the u-v graph of convex lens 
53.	The focal length of a double convex lens is equal to radius of curvature of either surface. The refractive index of its material is i) 1 ii) 3/2 iii) 4/3 iv) None of these
54.	Two lenses of focal lengths 20cm and -40cm are held in contact. The image of an object at infinity will be formed by the combination at i) Infinity ii) 20cm iii) 40cm iv) 60cm
55.	A thin prism of 6^0 angle of prism gives a deviation of 3^0. The refractive index of the material of the prism is i) 1 ii) 4/3 iii) 3/2 iv) 2
56.	A equilateral prism is made of material of refractive index $\sqrt{3}$. Angle of minimum deviation through prism is i) 60^0 ii) 30^0 iii) 45^0 iv) 90^0
57.	An astronomical telescope has magnifying power of 10. In normal adjustment, distance between the objective and eyepiece is 22cm. The focal length of objective lens is i) 10cm ii) 22cm iii) 20cm iv) 2cm
58.	The effective focal length of the lens combination shown in figure below is -60cm. The radii of curvature of the curved surface of the plano convex lenses are 12cm each and refractive index of

	the material of lens is 1.5cm. The refractive index of the liquid is:  i) 1.33 ii) 1.42 iii) 1.53 iv) 1.6
59.	A converging beam of rays is incident on a diverging lens. Having passed through the lens, the rays intersect at a point 15cm from the lens on the opposite side. If the lens is removed the point where the rays meet will move 5cm closer to the lens. The focal length of the lens is i) -10cm ii) 20cm iii) -30cm iv) 5cm
60.	A bi-convex is lens is formed with two thin plano-convex lenses as shown in fig. Refractive index n of the first lens is 1.5 ans that of second lens is 1.2. Both the curved surfaces are of the same radius of curvature R= 14cm. For this bi-convex lens, for an object distance of 40cm, the image distance will be  i) -280cm ii) 40cm iii) 21.5cm iv) 13.3cm
61.	A plano convex lens fits exactly into a plano concave lens. Their plane surfaces are parallel to each other. If lenses are made of different materials of refractive indices μ_1 and μ_2 and R is the radius of curvature of the lenses, then the focal length of combination is: i) $\frac{2R}{(\mu_2 - \mu_1)}$ ii) $\frac{R}{2(\mu_2 - \mu_1)}$ iii) $\frac{2}{2(\mu_1 - \mu_2)}$ iv) $\frac{R}{(\mu_1 - \mu_2)}$
62.	The refractive index of the material of a prism is $\sqrt{2}$, and its refracting angle is 30^0. One of the refracting surfaces of the prism is made a mirror inwards. A beam of monochromatic light entering the prism from the other face retraces its path, after reflection from mirrored surface, if its angle of incidence on prism is: i) 0^0 ii) 30^0 iii) 45^0 iv) 60^0
63.	The magnifying power of a telescope is 9. When it is adjusted for parallel rays the distance between the objective and eyepiece is 20cm. The focal length of lenses are: i) 10cm, 10cm iii) 18cm, 2cm ii) 15cm, 5cm iv) 11cm, 9cm
64.	For angle of minimum deviation of a prism to be equal to its refracting angle, the prism must be

	made of material whose refractive index: i) Is less than one iii) lies between √2 and 1 ii) Lies between 2 and √2 iv) is greater than 2
65.	Following is the (1/u) – (1/v) graph for a convex lens. What will be its focal length  i) 0.05cm ii) 5m iii) 2m iv) 20cm
66.	A ray of light falls on the surface of a spherical glass paper weight making an angle α with the normal and is refracted in the medium at an angle β. The angle of deviation of the emergent ray from the direction of the incident ray is: i) (α-β) ii) 2(α-β) iii) (α-β)/2 iv) (β-α)
67.	A glass prism of refractive index 1.5 is immersed in water (refractive index 4/3). A light beam incident normally on the face AB is totally reflected to reach the face BC, if:  i) Sin C= 8/9 ii) Sin C= 9/8 iii) SinC= 2/3 iv) SinC= 3/2
68.	A plano convex lens has focal length f=20cm. If its plane surface is silvered, then new focal length will be i) 20cm ii) 5cm iii) 10cm iv) 25cm
69.	In an optics experiment, with the position of the object fixed, a student varies the position, the screen is adjusted to get a clear image of the object. A graph between the object distance u and image distance v from the lens, is plotted using the same scale for two axes. A straight line passing through origin and making an angle of 45^0 with the x- axis meets the experimental curve at P. The coordinate of P will be i) $\{\frac{f}{2}, \frac{f}{2}\}$ ii) (f,f) iii) (4f,4f) iv) (-2f,2f)
70.	A concave mirror of focal length f_1 is placed at a distance of‘d’ from a convex lens of focal length f_2. A beam of light coming from infinity and falling on this lens-mirror combination returns to infinity. The distance ‘d’ must equal: i) F_1+f_2 ii) $-f_1+f_2$ iii) $2f_1+f_2$ iv) $-2f_1+f_2$

WAVE OPTICS

1. A wavefront is an imaginary surface where
   a) Constant phase difference continuously changes between the points
   b) Phase changes over all the surface
   c) Phase is same for all points
   d) Phase changes at constant rate at all points along the surface
2. A plane wavefront falls on a convex lens, the emergent wavelength is
   a) Plane b) cylindrical c) spherical diverging d) spherical converging
3. When two light waves meet at a place
   a) Their displacements add up
   b) Their intensiies add up
   c) Both add up
   d) Energy becomes zero
4. In Young's double slit experiment, the separation between the slits is halved and the distance between the slits and the screen is doubled. The fringe width is
   a) Unchanged b) halved c) doubled and d) quadrupled
5. In Young's double slit experiment, the separation between the slits is doubled and the distance between the slits and the screen is also doubled . The fringe width is
   a) Unchanged b) halved c) becomes and d) quadrupled
6. Two coherent monochromatic light beams of intensity I and 4I are superposed. The maximum and minimum possible intensities in the resulting beam are
   a) 5I and I b) 5I and 3I c) 9I and I d) 9I and 3I
7. In a double slit experiment instead of taking slits of equal width, one slit is made twice as wide as the other, then in the interference pattern
   a) The intensities of both maxima and minima increase
   b) The intensity of the maxima increases and the minima zero intensity
   c) The intensity of the maxima decreases and that of the minima increases
   d) The intensity of the maxima decreases and the minima has zero intensity
8. In a Young's double slit experiment , the slit width ratio is 1:25, then the ratio of the maximum and minimum intensity of the interference of light is
   a) $\frac{4}{9}$ b) $\frac{9}{4}$ c) $\frac{121}{49}$ d) $\frac{49}{121}$
9. In a Young's double slit experiment, 12 fringes are observed to be formed in a certain segment of the screen when light of wavelength 600nm is used. If the wavelength is changed to 400nm, the number of fringes formed in the same segment of the screen is
   a) 12 b) 18 c) 24 d) 30
10. In Young's double slit experiment, the intensity at a point is $1/4^{th}$ of the maximum intensity. Angular position of this point is

a) $Sin^{-1}(\lambda/d)$ b) $Sin^{-1}(\lambda/2d)$ c) $Sin^{-1}(\lambda/3d)$ d) $Sin^{-1}(\lambda/4d)$

11. To demonstrate the phenomenon of interference, we require two sources which emit radiation
    a) Of nearly the same frequency
    b) Of same frequency
    c) Of different wavelengths
    d) Of same frequency and having a definite phase relationship
12. Two coherent sources are represented by $y_1 = a_1 cos\omega t$ and $y_2 = a_2 sin\omega t$. The resultant intensity due to interference will be
    a) $a_1 + a_2$ b) $a_1 - a_2$ c) $a_1^2 + a_2^2$ d) $a_1^2 - a_2^2$

13. The path difference between two waves
    a) $\frac{\lambda}{2}\pi$ b) $\frac{\lambda}{2\pi}\left(\phi + \frac{\pi}{2}\right)$ c) $\frac{\lambda}{2\pi}\left(\phi - \frac{\pi}{2}\right)$ d) $\frac{\lambda}{2\pi}\phi$
14. In the phenomenon of interference, energy is
    a) Destroyed at bright fringe
    b) Created at dark fri nge
    c) Conserved but redistributed
    d) Same at all points
15. Monochromatic light is a light in which
    a) Single wavelength is present
    b) Various wavelengths are present
    c) Red and violet lights are present
    d) Yellow and red lights are present
16. If white light is used in Young's double slit experiment
    a) the fringe closest on either side of the central white fringe is red and the farthest will appear blue
    b) the fringe closest on either side of the central white fringe is blue and the farthest will appear red
    c) the fringe closest on either side of the central white fringe will appear white
    d) no fringes will be formed
17. In Young's double slit experiment, the fringe width is measured to be 0.4mm. If the whole apparatus is immersed in water of refractive index $\mu = \frac{4}{3}$, the new fringe width will be
    a) 0.3mm b) 0.4mm c) 0.53mm d) 45microns
18. In Young's double slit experiment, if L is the distance between slits and the screen up to which interference is observed, x is angular distance between adjacent fringes and d the slit separation then wavelength λ is equal to
    a) $\frac{xd}{L}$ b) $\frac{xL}{d}$ c) $\frac{Ld}{x}$ d) $\frac{1}{Ldx}$

19. In a Young's double slit experiment, the interference fringes of width 1mm each are obtained for a light of wavelength $5000A^0$. If the wavelength of light is changed to $6000A^0$ without altering the other parameters, the new fringe width will be
    a) 0.5 b) 1.0 c) 1.2 d) 1.5
20. In Young's double slit apparatus for interference is shifted from air to water , the width of the fringes
    a) Becomes infinite b) decreases c) increases d) unchanged
21. In a Young's double slit experiment , the distance between two slits is 1mm , the distsnce between the screen and the slits is 1m, and a red light of wavelength 6.5×10^{-7} m is used to illuminate the slits, then the distance between third dark fringe and fifth bright fringe is
    a) 0.65 mm b) 1.63mm c) 3.25mm d) 4.88mm
22. In Young's double slit experiment , if the wavelength of incident light is $6000A^0$, the distance of screen from the slits is 40cm, and the width of fringe obtained is 0.012cm, then the distsnce between two slits is
    a) 0.024 cm b) 2.4cm c) 0.24cm d) 0.2 cm
23. Young's double slit experiment established
    a) Light consists of particles
    b) Light consists of waves
    c) Light has dual nature'
    d) Nature of light cannot be established
24. Interference is shown by
    a) Longitudinal mechanical waves only
    b) Transverse mechanical waves only
    c) Non-mechanical transverse waves only
    d) All of the above
25. The intensity of bright and dark fringes are 4I and I . The ratio of amplitude of two waves is given by
    a) 1:1 b) 1:4 c) 3:1 d) 1:2
26. In a given set up of Young's double slit experiment, the width of fringe width will be minimum for
    a) Red b) green c) violet d) yellow
27. The shape of wave front for a point source of light is
    a) Cylindrical b) circular c) plane d) spherical
28. According to Huygen's principle, which among the following statements is true
    a) The time taken by all the secondary wavelets to reach the corresponding point in the secondary wave front is same irrespective of the medium in which it travels
    b) The distance travelled by all the wavelets is same irrespective of the medium in which it travels
    c) The velocity of all the wavelets is same in all medium
    d) None of the above quantities remain constant

29. A plane wavefront is incident on a prism. The shape of emerging wavefront
   a) Cylindrical b) spherical c) plane d) either plane or spherical
30. In the Doppler effect of light waves,
   a) when the source moves away from the observer the frequency as measured by the source will be smaller
   b) when the source moves towards the observer the frequency as measured by the source will be smaller
   c) when the source moves away from the observer the wavelength as measured by the source will be smaller
   d) when the source moves towards the observer the wavelength as measured by the source will be larger
31. In a Young's double slit experiment, the distance between the screen and the slits is doubled. The angular separation of the fringes and the separation of the fringes
   a) Increases and decreases
   b) Decreases and increases
   c) Remains same and increases
   d) Increases and remain same
32. In a Young's double slit experiment, if s is the size of the source slit, S the distance of source slit form the double slits, d the distance between two slits and λ the wavelength of incident monochromatic light, then the condition for interference fringes to be seen clearly is
   a) $\frac{S}{s} = \frac{\lambda}{d}$ b) $\frac{s}{S} = \frac{\lambda}{d}$ c) $\frac{s}{S} = \frac{d}{\lambda}$ d) $\frac{S}{s} = \frac{d}{\lambda}$
33. In Young's double-slit experiment using monochromatic light of wavelength λ , the intensity of light at a point on the screen where path difference is λ , is K units. The intensity of light at a point where path difference is $\frac{\lambda}{3}$ is
   a) $\frac{K}{2}$ b) zero c) K d) $\frac{K}{4}$
34. Young's double slit experiment is first performed in air and then in a medium other than air. It is found that 8^{th} bright fringe in the medium lies where 5^{th} dark fringe lies in air. The refractive index of the medium is nearly
   a) 1.25 b) 1.59 c) 1.69 d) 1.78
35. In double-slit experiment using light of wavelength 600 nm, the angular width of a fringe formed on a distant screen is 0.1°. The spacing between the two slits is
   a) 3.44×10^{-4} m b) 2.44×10^{-4}m c) 3.44×10^{-3} m d) 2.44×10^{-3}m
36. Which phenomena of principle cannot be explained using Huygen's principle
   a) Reflection and refraction
   b) polarisation
   c) Interference and diffraction
   d) Photoelectric effect
37. In the wave picture, the intensity of light is determined by

a) The amplitude of the wave
b) The square of amplitude of the wave
c) The frequency of the wave
d) The wavelength of the wave

38. The maximum intensity in a Young's double slit experiment is I_0. The distance between the two slits is 5λ. If the distance between the screen and the slits is equal to 10d, the intensity of light in front of one of the slits on screen is

a) $\frac{I_0}{2}$ b) $\frac{3}{4}I_0$ c) I_0 d) $\frac{I_0}{4}$

39. For double slit experiment, the two coherent sources are $y_1 = 10sin\omega t$ and $y_2 = 10\sin\left(\omega t - \frac{\pi}{6}\right)$. Then the value of intensity of bright fringes will be

a) 20 b) 400 c) 100 d) 200

40. In a young's double slit experiment, the intensity at a point where the path difference is $\frac{\lambda}{6}$ is I. If I_0 denotes the maximum intensity, $\frac{I}{I_0}$ is equal to

a) $\frac{3}{4}$ b) $\frac{1}{\sqrt{2}}$ c) $\frac{\sqrt{3}}{2}$ d) $\frac{1}{2}$

41. what do you mean by diffraction of light?
42. what is the essential condition for diffraction of wave?
43. what is the condition for first minima in case of diffraction due to single slit?
44. why are short waves used in long distance broadcasts?
45. Write down the expression for the width of central maximum of the diffraction pattern produced by a single slit?
46. how is the width of central maximum related to the width of the slit?
47. How is the spreading of light due to the diffraction of light depends on the wave length of light?
48. Give one basic difference between interference and diffraction?
49. what is polarisation of light?
50. what is plane polarised light?
51. what evidence is there to show that sound is not electromagnetic in nature?
52. the polarising angle for slab is 60 degree. Calculate its refractive index?
53. Write the formula for Malus Law?
54. what is a Polaroid?
55. Name the phenomena which illustrate the transverse nature of light?
56. what happens to the intensity of light when it is polarised?
57. Value of the Brewster angle for a transparent medium is different for lights of different colours. How?
58. Define polarising angle for polarisation by reflection?
59. what do you mean by crossed Polaroid?

60. State Brewster law of polarisation?
61. what is the significance of polarisation?
62. what is the angle between the plane of polariser and that of an analyser, in order that the intensity of light reduces to half?
63. for listening radio in cars, external radio aerials are used because?
64. Effect of diffraction is greatest if waves pass through a gap with width equal to?
65. Spreading of wave as it passes through a gap or around an edge is called?
66. which material is used in manufacturing of artificial Polaroid?
67. Optically active substance are those which?
68. which waves cannot be polarised?
69. which phenomena confirm that light waves are transverse?
70. in single slit diffraction pattern, how does the width of central maximum change when light of smaller wavelength is used?
71. Sound waves are not electromagnetic waves. Why?
72. the angle between pass axis of polarizer and analyser is 45 degree. The percentage of polarised light through the analyser is?
73. in going from a rarer to a denser medium, light loses some speed. What happen to its energy carried by the light waves?
74. why do we not encounter diffraction effects of light in everyday observations?
75. a single slit diffraction experiment is immersed completely in water without changing any other parameter. How is width of central maximum affected?
76. A ray of light falls on a transparent slab of μ=1.732. if reflected and refracted rays are mutually perpendicular, what is the angle of incidence?
77. in a plane polarised light, name three parameters which are mutually perpendicular?
78. which among x rays, sound waves and radio waves can be polarized?
79. Does the values of polarizing angle depends upon colour of light?
80. How is the diffraction pattern observed when source is emitting white light?

DUALNATURE OF RADIATION AND MATTER

1. Name the particle which associated of bundle of energy of electromagnetic wave?
   a) Proton b) electron c) Photon d) beta particle
2. Which of the following metal has more sensitive for photoelectric emission ?
   a) calcium b) Caesium c) sodium d) copper
3. Photo electric effect is the -----------
   a) Process of emission of electrons
   b) process of emission of protons
   c) process of emission of neutrons
   d) process of emission of positive charges
4. Name the metal which has high work function
   a) Sodium b) Nitrogen c) Zinc d) cadmium

5. What is the unit used to measure the work function?
   a) Electron volt b) joule c) Ampere d) volt
6. On which of the following factor the number of emitted electrons depends ?
   a) Frequency b) Intensity of incident light
   c) Stopping potential d) None of the above
7. On which of the following factor the maximum kinetic energy of photo electron depends?
   a) Stopping potential b) Frequency c) Intensity d) None of the above?
8. Four metals A , B,C and D having work functions of 2ev, 3ev, 5ev and 6evrespectively, Which metal has lower threshold wave length for photo electric effect?
   a)A b) B c) C d)D
9. Which of the following equation represents for Eineistin photo electric equation?
   a) $KE = hv - w_0$ b) $KE = hv + w$ c) $KE = hv \times w$ d) hv / w
10. If proton and deuteron are have the same velocity . What is the ratio of their de Broglie wave length?
    a)2:1 b) 3:4 c) 2:3 d) 5:6
11. Which one of the following is concerned with the de- Broglie wave ?
    a) Light b) Moving mass particle c) Photon d) None of the above
12. Davisson and Germer experiment is significant to which of the following
    a) wave nature of proton b) wave nature of photon
    c) wave nature of electron d) None of the above
13. Which of the following wave not associated with electromagnetic?
    a) Radio wave b) Micro wave c) Matter wave d) gamma rays
14. Which one of the following statements about photon is not correct?
    a) Photons exert pressure b)Photon energy is hf
    c) Momentum of Photon is hf/c d) Photon rest mass is zero
15. If h is Planck's constant the momentum of photon of wavelength 0.01Å is
    a) $h\times10^{-2}$ b) h c) $h\times10^{2}$ d) $h\times10^{12}$
16. A metal with work function of 0.6ev is illuminated with alight of 2ev , The stopping potential is ?
    a) 2.6ev b) 3.6ev c) 1.4ev d) 0.8ev
17. Photoelectric effect supports quantum nature of light?
    a)There is a minimum frequency of light below which no photoelectrons are not emitted
    b) the maximum energy of photoelectron depends only on the frequency of light and not its intensity
    c) photoelectric effect is instantaneous process
    d)All the above choice are correct.

18. A photocell is
    b) Converts light into electricity b) converts electricity into light
    c) stores electricity d) stores light.
19. Which one of the following is the frequency of a photon whose energy is 75ev?
    a) $18x10^{15}$ Hz b) $4x10^{12}$ Hz c)$12x10^{13}$ Hz d) $10x10^{15}$Hz
20. The slope of graph drawn between frequency and stopping potential is
    a) h/e b) h c)e d)he

iii)

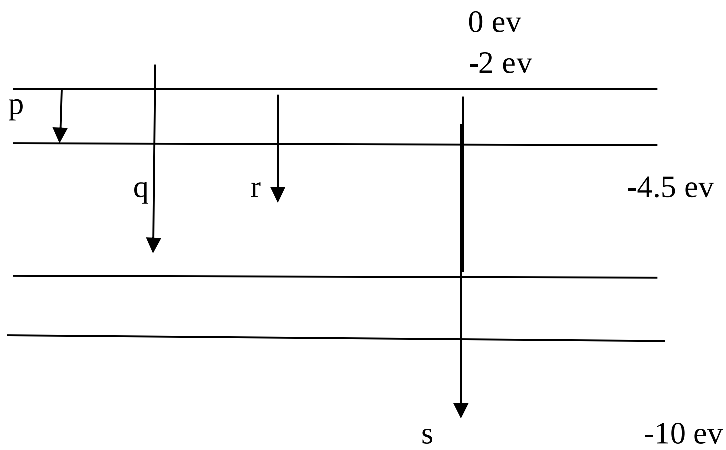
21. Which of the following is not dependent on the intensity of radiation ?
    A) amount of photo current b) kinetic energy of photoelectrons
    c) stopping potential d) data incomplete
22. Momentum of a photon is P , The corresponding wavelength is
    a) h/2p b) h/p c) hp d) p/h
23. The De Broglie wave corresponding to particle of mass m and velocity v has a wavelength associated with it ?
    a) hmv b)m/ hv c) h/mv d) mh/v
24. What energy should be added to an electron to reduce its de Broglie wavelength from 10^{-10}m to $0.5x10^{-10}$m
    a) 4 times the initial energy b) 3 times the initial energy
    c)2 times the initial energy d) equal to initial energy
25. What will be the ratio of the de Broglie wave length of proton and alpha – particle of the same energy ?
    a) 2:1 b) 1:2 c) 4:1 d) 1:4
26. If we consider electrons and photons of the same wave length, They will have the same ?
    a) velocity b) energy c) momentum d) angular momentum
27. Light of wave length 4000Å is incident on a sodium surface for which the threshold wave length of photoelectrons is 5420Å?
    a) 0.57ev b) 2.29ev c)3.1ev d) 4.2ev
28. Light of two different frequencies whose photons energies of 1ev and 2.5ev respectively, illuminate successively a metal having work function 0.5ev. The ratio of maximum speed of emitted electrons is ?
    a)1:2 b) 2:3 c) 4:5 d) 2:5
29. The work function of a metal is 2.51ev, Its threshold frequency is
    a) $6.5x10^{13}$ Hz b) $9.4x10^{12}$ Hz c) 6.08 $x10^{14}$Hz d)$5.8x10^{11}$Hz
30. Ultraviolet radiation of 6.2ev falls on an aluminum work function 4.2ev, The KE in joules of faster electron is ?
    a) $4.2x10^{-12}$ j b) $3x10^{-19j}$c) $1.4x10^{-18}$j d) $2.65x10^{-16}$j

31. Which of the following radiation will be more effective for electron emission from he surface of Zinc ?
    a) Radio waves b) microwaves c) ultraviolet waves d) infrared rays
32. If the potential difference used to accelerate electrons is tripled, by what factor does de Broglie wavelength of electrons beam change?
    a)1/2 b) 1/3 c) ¼ d) 2/3

33. Maximum velocity of photoelectrons emitted is 4.8m/s, If e/m ratio of electron is $1.76\text{x}10^{11}$c/kg , Then stopping potential is given by ?
    a)$5\text{x}10^{-10}$j/c b)$7\text{x}10^{-11}$j/c c)$3\text{x}10^{-7}$ j/c d) Zero
34. A photon in a motion has mass equal to
    a) hf/ C^2 b) hf c) c/hf d) h/c
35. Momentum of a photon is P the corresponding wave length is
    a)h/p2 b)h/p c) ph d)p/h

ATOMS

1. How will the distance of closest approach be affected when kinetic energy of alpha particle is tripled?
2. In the figure given below which of the transition corresponding to
   (i). Maximum and (ii). Minimum wavelength.



3. De Broglie's wavelength equation confirms Bohr's quantum condition. Justify.
4. What are the limitations of Rutherford's model which could not explain the observed features of atomic spectra? How were these explained in Bohr's model of hydrogen atom?

5. Short wavelength of Lyman series of hydrogen atom is 913.4 $\dot{A}$. Calculate short wavelength limit of Balmer series.

6. If the electron in the atom is replaced by a particle having the same charge but mass 400 times as that of electron, how would the radius and ground state energy be affected?

7. Ground state energy of hydrogen atom is -13.6 eV. What is the energy required to move an electron from ground state to 3rd excited state?
8. What is the magnetic moment of the electron revolving around the nucleus in a radius ‘r’ with orbital speed ‘v’?
9. In which of the following atoms will the radius of first orbit be minimum?

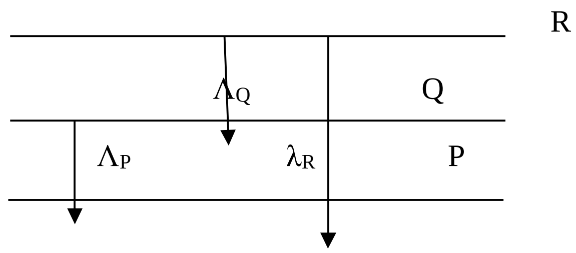
   (a). Deuterium (b). Hydrogen (c). Doubly ionised Lithium.

   (d). Singly ionised Helium.

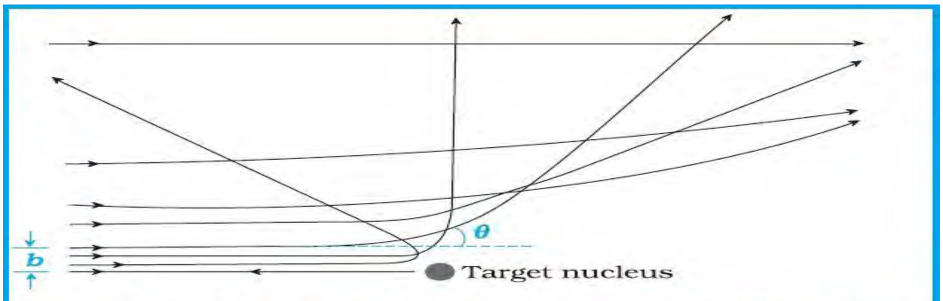
10. Why do wavelengths involved in the doubly ionised Lithium spectrum are slightly different from those of hydrogen spectrum?
11. What would happen if the electrons in an atom were stationary?
12. Why is a very thin gold foil used in the α-scattering experiment?
13. What is impact parameter of α-particle scattered through 180 degrees?
14. Name the series of hydrogen spectrum lying in ultraviolet and visible region.
15. What is the Bohr quantization condition for the angular momentum of an electron in first excited state?
16. The wavelength of some of the spectral lines obtained in hydrogen spectrum are $9546\dot{A}$, $6463\dot{A}$ and $1216\dot{A}$. Which of these belong to Lyman series?
17. What is Bohr’s radius?
18. Energy of electron in the ground state of hydrogen atom is 13.6eV. What is the value of electron in the same state of He+ atom?
19. What is the significance of negative energy of the electron in the orbit?
20. What is the importance of distance of closest approach?
21. Energy of the ground state of hydrogen atom is equal to -13.6eV. What is the energy of first exited state of He+ atom.
22. When is H_α line of Balmer series in the emission spectrum of hydrogen obtained?
23. What is the maximum number of spectral lines emitted by a hydrogen atom when it is in the fifth exited state?
24. The radius of the inner most electron of hydrogen atom is

    $5.3*10^{-11}$m .what is its radius –n=3 orbit?

25. The total energy of an electron in the first exited state of hydrogen atom is -3.4eV .what is the kinetics energy and potential energy in the state ?
26. Find the relation between the three wavelengths λ_P , λ_Q and λ_R from energy level diagram



27. Calculate the shortest wavelength of the spectral lines emitted in Balmer series.
28. The ground state energy of hydrogen atom is -13.6eV. If electron Make transmission from an energy level -0.85eV. What is the wave length of the spectral line emitted?
29. Estimate the ratio of De **B**roglie wavelengths associated with deuterons and α-particles when they are associated from rest through the same accelerating potential V.
30. The electron in hydrogen atom is initially in the third exited state
    What is the max number of spectral lines which can be emitted when it finally move to the ground state?
31. When an electron falls from a higher energy to lower energy level, the difference in the energies appears in the form of electromagnetic radiation. Why can't it be emitted as other forms of energy?
32. Why do alpha particles have high ionising power?
33. Would the Bohr formula for H- atom remain unchanged if proton had a charge (+4/7) e and electron had a charge (-7/4) e. Justify your answer.
34. For two different H-atom the electron in each atom is in an excited state. Is it possible for the electrons to have different energies with the same orbital angular momentum according to Bohr model?
35. The trajectories traced by different alpha particles in Geiger Marsden experiment were observed as shown in figure.



Trajectory of α-particles in the coulomb field of a target nucleus. The impact parameter, *b* and scattering angle *θ* are also depicted.

What are the values of 'b' for θ= 0degrees and πradius ?

36. The wave number of a spectral line equals R, the Rydberg constant 1.097x$10^7 m^{-1}$
    Express the wave length of this line in Å.
37. Which is easier to remove: orbital electron from an atom or a nucleon from a nucleus?
38. In alpha particle scattering experiment 1 in 8000 retrace its path. What do you infer from this**?**
39. When the electron hitting in H-atom in its ground state moves to the 3^{rd} excited state, how the deBrogile wave length associated with it would be affected?
40. In the Rutherford scattering experiment the distance of closest approach is d0. If α particle is replaced by proton how much Kinetic energy in comparison to α particle with it require to have the same distance of closest approach do?

41. The ratio of energy of Bohr's hydrogen atom and He^+ atom in the first orbit is:
a)1:2 b)4:1 c)1:4 d)1:9
42. As per Bohr model, the minimum energy in eV required to remove an electron from the ground state of Li^{++} is:
a) 1.51 b)13.6 c) 40.8 d) 122.4
43. The wavelength associated with a gold ball of 200g moving with 5m/h is of the order of :
a) 10^{-10}m b)10^{-20}m c) 10^{-30}m d)10^{-40}m
44. In which region of electromagnetic spectrum does the Lyman series of hydrogen atom is:
a) Ultraviolet b) X-rays c) Infra-red d) visible
45. How many kV potential is to be applied on X-ray tube so that minimum wavelength of emitted X-ray may be 1 Å?
a) 12.48kV b) 12.84kV c) 11.98kV d) 1078kV
46. The ratio of the kinetic energy to the potential energy of an electron in Bohr orbit is:
a) 1: -1 b) 1: -2 c) 2:1 d) 2: -1
47. Electrons are bombarded to excite hydrogen atoms and six spectral lines are observed. If E_g is the ground state energy of hydrogen, the minimum energy the bombarding electrons should possess is: a) 8 E_g/9 b) 15 E_g/16 c) 35 E_g/36 d) 48 E_g/49
48. If the atom $_{100}Fm^{257}$ follows the Bohr model and the radius of last orbit of $_{100}Fm^{257}$ is n times the Bohr radius then value of n is:
a) 100 b)200 c)4 d)1/4
49. Hydrogen atom does not emit X-rays because:
a) It contains only single electron
b) energy levels in it are far apart
c) its size is very small
d) energy levels in it are very close to each other
50. A hydrogen atom is in excited state of principal quantum number n. It emits a photon of wavelength λ when it returns to ground state: a) $\sqrt{\lambda R(\lambda R-1)}$ b)$\sqrt{\lambda R}/(\lambda R-1)$
c) $\sqrt{\lambda R-1}/\lambda R$ d) $\sqrt{\lambda}/(\lambda R-1)$
51. In a hydrogen atom the magnetic field at the centre of the atom produced by an electron in the n^{th} orbit is proportional to:
a) $1/n^2$ b) $1/n^3$ c) $1/n^4$ d) $1/n^5$
52. Energy levels in an atom are in discrete manner in
a) Thomson's experiment c) Rutherford's experiment
b) Millikan's oil drop experiment d) Franck and Hertz experiment
53. An electron of a stationary hydrogen atom passes from the fifth energy level to the ground level. The velocity that the atom acquired as a result of photon emission will be:
a) 24m/25hR b) 24 hR /25m c) 25hR / 24m d) 25m/24hR
54. The De Broglie wavelength of the electron in the ground state of the hydrogen atom is:
a) 1.67 Å b) 3.33 Å c) 1.06 Å d) 0.53 Å

55. If a electron in a hydrogen atom has moved from n=1 to n=10 orbit the potential energy of the system has:
    a) Increased b) decreased c) remain unchanged d) become zero

NUCLEI

1. What law did Ernest Rutherford use to estimate the size of the nucleus?
    A. Conservation of nucleon number
    B. Conservation of angular momentum
    C. Conservation of linear momentum
    D. Conservation of energy
    E. Conservation of charge
2. Why are nuclear energy levels more complex than electron energy levels?
    a. Nuclear energy levels depend only on attractive forces.
    b. Nuclear energy levels depend on attractive and repulsive forces.
    c. Nuclear energy levels are an order of one hundred times as great as electron energy levels.
    d. Electron energy levels depend on the interaction between neutrons and electrons.
    e. Electron energy levels have greater energy than the nuclear energy levels.
3. Which of the following about the nuclear force is true?
    a. It is an attractive force between electrons and protons in an atom.
    b. It is much weaker than the electromagnetic force.
    c. It is much weaker than the gravitational force.
    d. It is a strong, short-range, attractive force between the nucleons.
4. What force is responsible for the radioactive decay of the nucleus?
    a. Gravitational force
    b. Weak Nuclear force
    c. Strong Nuclear force
    d. Electromagnetic force
5. Isotopes of an element:
    a. have the same number of protons and electrons, but a different number of neutrons.
    b. have the same number of protons and neutrons, but a different number of electrons.
    c. have different number of protons.
    d. have different number of electrons.
    e. have the same number of neutrons and protons.
6. Binding energy is:
    a. the amount of energy required to break a nucleus apart into protons and neutrons.

b. the amount of energy required to break a nucleus apart into protons and electrons.
c. the amount of energy required to break a nucleus apart into electrons and neutrons.
d. the amount of energy released when neutrons change energy levels.
e. the amount of energy released when protons change energy levels.

7. If mH is the atomic mass of Hydrogen, mn is the mass of a neutron, and M is the atomic mass of the atom, which of the following is the mass defect formula?

A. $\Delta m = Z \cdot mH + N \cdot mn - M$

B. $\Delta m = Z \cdot mH + N \cdot mn + M$

C. $\Delta m = Z \cdot mH - N \cdot mn - M$

D. $\Delta m = Z \cdot mH - N \cdot mn + M$

E. $\Delta m = M - Z \cdot mH - N \cdot mn$

8. When nucleons form a stable nucleus, binding energy is:

A. created from nothing .
B. destroyed into nothing.
C. transformed into visible light.
D. absorbed as high energy photons or particles.
E. released as high energy photons or particles.

9. When a nucleus is divided into its constituents, energy is:

A. created from nothing.
B. destroyed into nothing.
C. transformed into visible light.
D. absorbed by the nucleus which then breaks it apart.
E. released by the nucleus as it breaks apart.

10. An isotope with a high Binding Energy per nucleon:

A. will decay in a short period of time.
B. is very unstable.
C. is very stable .
D. has very few electrons.
F. has more protons than neutrons.

11. Why do heavier nuclei have a greater ratio of neutrons to protons than lighter nuclei?

A. to add more nucleons so that the binding energy is greater.
B. to provide a greater weak nuclear force.
C. to provide more attractive electromagnetic force.
D. to provide more attractive strong nuclear force to balance the repulsive electromagnetic force.

E. to provide more repulsive strong nuclear force to balance the attractive electromagnetic force.

12. A reaction that releases more energy than is put into it is called:
Endothermic B. exothermic C. nuclear D. chemical E. radioactivity

13. The following reaction: ${}_0n^1 + {}^{235}U_{92} \rightarrow {}^{141}Be_{56} + {}_{36}Kr^{92} + 3n_0^1$ is

A. Fusion B. Fission C. alpha decay D. beta decay E. gamma decay

14. The nuclei ${}_{53}I^{131}$ and ${}_{53}I^{127}$ contain the same No of

(a) Quarks
(b) Neutrons
(c) Nucleons
(d) Protons

15. Mass of the fuel required to generate energy of 1000 MW will be

(a) 0.01 μg/sec
(b) 5.2 mg/sec
(c) 0.01 mg/sec
(d) 4.73 kg/minute

16. 1MeV is

(a) 1.6×10^{-19}J
(b) 1.6×10^{-22}J
(c) 1.6×10^{-13}J
(d) 1.6×10^{-9}J

17. If an H- nucleus is completely converted into energy, the energy produced will be around

(a)1MeV (b) 939MeV (c) 9.39MeV (d)238MeV

18. The nuclear forces are

(a)Charge dependent (b) Spin dependent (c) charge independent (d)long range

19. Which is non central force

(a)Electrostatic force (b) Nuclear force (c) Gravitational force (d)None of the above

20. The curve of binding energy per nucleon as a function of mass number has a sharp peak for helium nucleus. This implies that helium

(a)Can easily be broken up (b) is very stable (c) can be used as fissionable material
(d) Is radio active

21. Binding energy per nucleon in heavy nuclei is of the order of

(a)8MeV (b) 8eV (c) 80eV (d)80MeV

22. If r1 and r2 are the radii of the atomic nuclei of mass number 64 and 125respectively, then the ratio r1/r2 is

(a)64/125 (b) $(64/125)^{1/2}$ (c) 5/4 (d)4/5

23. The atomic number and mass number of an atom remain unchanged when it emits

(a)a photon (b) a neutron (c) β- particle (d)α- particle

24. A nucleus X is initially at rest , undergoes alpha decay according to the equation

$_{92}X^{A} \longrightarrow {}_{Z}Y^{238} + \alpha$ Then the values of A and Z are

(a)94,230 (b) 242,90 (c) 190,32 (d)230,94

25. Which of the following is sitable for fusion process

a) light nuclei (b) heavy nuclei
(c) elements lying in the middle of the periodic table
(d) middle elements , which are lying on the middle of the binding energy curve

26. During the β-decay

(a) An atomic electron is released
(b) An electron , already present with the nucleus, is released
(c) A proton in the nucleus decays emitting an electron
(d) A neutron in the nucleus decays emitting an electron

27. .One curie is equal to

(a) 3.7×10^{10}disintegrations/s
(b) 3.2×10^{8}disintegrations/s
(c) 2.8×10^{10}disintegrations/s
(d) None of the above

28. Mean life of a radioactive sample is 100s, then its half life (in minutes) is

(a) 0.693 (b) 1 (c) 10^{-4} (d)1.155

29. A thorium nucleus emits an α particle . Which of the following fundamental physics principles can be used to explain why the direction of the daughter nucleus recoil must be in the opposite direction of the α emission

I - Newton's third law II -Conservation of momentum III- conservation of energy

(a) Only II (b) Only III (c) I and II only (d)II and III only

30. Half life of a radioactive material is 2 days. If the original material is 1 kg, then how much of it will be left after 6 days ?

(a) 125g (b) 250g (c) 500g (d) 750g

31. Half-life period of a radioactive element X is same as the mean-life time of another radioactive element Y. If initially both have same number of atoms, then

(a) X decay faster than Y (b) Y decay faster than X

(c) X and Y decay at same rat (d) Initial decay rate of X and Y are same

32. Half life of an atom A is 2 days. If we start with 60,000 atoms of that material, number of atoms left over after 8 days will be

a) 1875 (b) 3750 (c) 7500 (d) 15000

33. If the half of a radioactive material is 2 days at NTP, then on increasing the pressure to 16 atmospheres, new half. life of the material will be

a) 16 days (b) 8 days (c) 4 days (d) 2 days

34. A Nucleus of 84Po210 originally at rest emits alpha particle with speed v > What will be recoil of the daughter nucleus

a) 4v/206 (b) 4v/214 (c) 4v/(A+4) (d) 2v/(A+4)

35. A radio active nucleus undergoes alpha emission to form a stable element. What will be the recoil velocity of the daughter nucleus if v is the velocity of alpha emission

a) 4v/A-4 (b) 2v/A-4 (c) 4v/(A+4) (d) 2v/(A+4)

36. A radio active nucleus undergoes beta emission to form a stable element. What will be the recoil velocity of the daughter nucleus if v is the velocity of beta emission

a) M_e v/A- M_e (b)) 4v/(A+4) (c) v (d) 4v/A-4

37. Fusion reaction takes place at high temperature because

a) nuclei break up at high temperature
b) atoms get ionized at high temperature
c) kinetic energy is high enough to overcome coulomb repulsion force between nuclei
d) molecules break up at high temperature

38. Light energy emitted by stars is due to

a) breaking of nuclei

b) joining of nuclei
c) burning of nuclei
d) reflection of solar light

39. The mass of alpha particle is

a) equal to sum of masses of two protons and two neutrons

b) equal to mass of 4 protons

c) less than sum of masses of two protons and two neutrons

d) equal to mass of 4 neutrons

40. If the nuclear force between proton-proton, proton-neutron and neutron-neutron are represented by F1,F2 and F3then

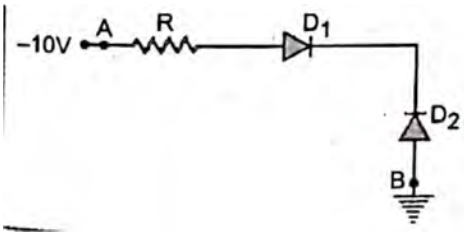
a) F1=F2=F3(APPROX)
b) F1=F2=F3(EXACT)
c) F1is not equal to F2but equal to F3
d) F1is not equal to F2not equal to F3

SEMI COUNDUCTOR ELECTRONIC DEVICES AND CIRCUITS

76. What will happen to the size of the depletion region in the forward bias of a p-n junction diode?
77. What will happen to the barrier potential when the Zener diode is forward biased
78. Zener diode is used as a voltage
    (a) rectifier (b) regulator (c) amplifier (d) oscillator
79. Singe p – n junction diode can be used in electronic circuit as
    (a) Full wave rectifier (b) Half wave rectifier (c) filter (d) switch
80. Symbol of p – n junction diode is
81. Symbol of Zener diode
82. Threshold voltage or cut in voltage in Germanium diode is
    (a) (a) ~ 0.2 V (b) ~ 0.3 V (c) ~ 0.4 V (d) ~ 0.5 V
83. The direction of diffusion current in an unbiased p-n junction diode is.
84. The current is reverse bias of a p-n junction diode is in the order of
    (a) Micro Ampere (b) Nano Ampere (c) mille Ampere (d) Pico ampere
85. Number of p-n junction diodes used in a full wave rectifier
    (a) One (b) two (c) Three (d) four

86. The frequency of pulsating (unsteady) DC in a half wave rectifier is
   (a) Equal to the frequency of AC
   (b) Double the frequency of AC
   (c) No relation with AC frequency
   (d) It needs calculation
87. The direction of drift current in an unbiased p-n junction diode is
88. When a photo diode is in use it is biased as
   (a) Forward bias (b) Reverse bias (c) unbiased (d) It can be any biasing
89. The I-V characteristics of a photo diode are drawn in the
   (a) First quadrant (b) Second quadrant (c) Third quadrant (d) Fourth quadrant
90. The photons emitted in LED are
   (a) Equal or slightly less than the band gap
   (b) Equal or slightly greater than the band gap
   (c) Equal to the band gap
   (d) Doesn't depend on the band gap
91. If the forward current on LED increases
   (a) Intensity of emitted light increases
   (b) Intensity of emitted light decreases
   (c) Intensity of emitted light has no relation with the forward current
   (d) None of the above
92. The composition of Gallium , Arsenic and Phosphorus in Red LED is
93. The energy band gap required to produce Infra Red LED is
94. Condition to generate electricity in a solar cell is
   (a) $h\nu > E_g$ (b) $h\nu < E_g$ (c) $h\nu = E_g$ (d) $h\nu -$ E_g
95. The typical I-V characteristics of a solar cell are drawn in
96. The current in forward bias is in the order of
   (a) Micro Ampere (b) Nano Ampere (c) mille Ampere (d) Pico ampere

97. Assuming the diodes to be ideal



   (a) D_1 is forward biased D_2 is reverse biased and hence current flows from A to B
   (b) D_2 is forward biased and D_1 is reverse biased and hence no current flows from B and A and vice versa
   (c) D_1 and D_2 are both forward biased and hence current flows from A to B
   (d) D_1 and D_2 are both reverse biased and hence no current flows A to B and vice versa.

98. In the depletion region of a diode

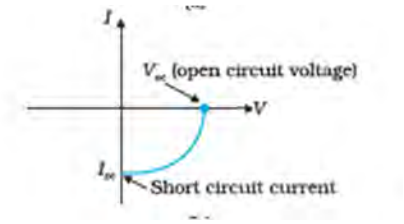
(a) There are no mobile charges

(b) Equal number of holes and electrons exist making the region neural

(c) Recombination of holes and electrons has taken place

(d) Immobile charged ions exist.

99.



The given graph represents I – V characteristic for a semiconductor device. Which of the following is correct ?

(a) It is I _ V characteristic for solar cell where point A represents open circuit voltage and point B short circuit current

(b) It is for a solar cell and points A and B represent open circuit voltge and current respectively

(c) It is for photodiode and points A and B represent open circuit voltage and current respectively

(d) It is for LED and points A and B represent open circuit voltage and short circuit current respectively

(e) It is for LED and points A and B represent open circuit voltage and short circuit current respectively.

100. Zener diode is designed to operate under

(a) Forward bias (b) Reverse bias (c) No bias (d) None of the above

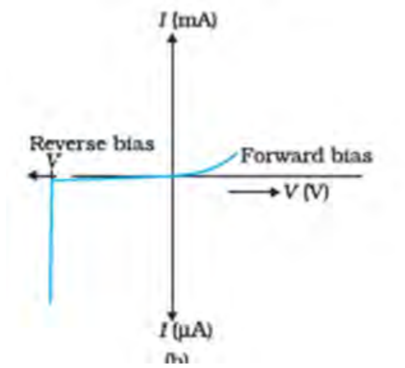
101. The size of depletion region is in the order of

(a) $<10^{-6}$ (b) $> 10^{-6}$ (c) $= 10^{-6}$ (d) No such relation exists

102. The magnitude of junction field in a Zener diode is of the order of

(a) $\sim 5x10^{6}$ V/m (b) $= 5x10^{6}$ V/m (c) $\sim 5x10^{7}$ V/m (d) $\sim 5x10^{-6}$ V/m

103. In the graph given below is the I – V characteristic of a special purpose p-n junction diode, identify the diode

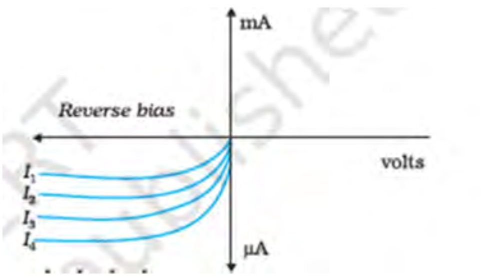


104. The current in Zener diode increases sharply after Zener voltage. The charges required for this current are drawn from

(a) Conduction band (b) Valence band (c) Forbidden band (d) Fermi level

105. What is the purpose of using a transparent window in a photodiode?

106.



The graph shown above is for a photodiode, where I_1, I_2, I_3, I_4 represent the intensity of light incidenting on the junction of photo diode. Which intensity of light produces highest photo current?

107. The reverse breakdown voltages of LED are very low, typically around

(a) 5 V (b) 6V (c) 7V (d) 8V

108. The light is emitted in LED due to

109. In a solar cell the thickness of p – Si wafer is about

(a) 300 μm (b) 200 μm (c) 100 μm (d) 25 μm

110. In a solar cell the thickness of n – Si wafer is about

(a) ~0.5μm (b) ~ 0.7μm (c) ~0.3 μm (d) ~ 0.8μm

111. Why photo diodes is always connected in reverse bias.

112. What is the size of Zener Diode?

(a) Its size remains constant (b) Its size is bigger than the p-n junction diode (c) Its size is smaller than the p-n junction diode (d) Its size changes according to the requirement of the circuit

113. Symbol for LED is

114. In the figure shown above which end is p- type material and which is n type material

115. Which semi conductor is used in making Blue LED

116. In a conductor conduction and valance bands are ________

117. Semiconducting device used to regulate an uninterrupted dc power supply is _______________

118. GaAs is used in __________ diode

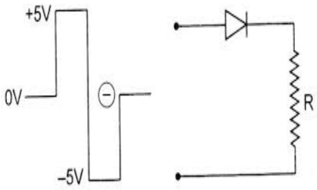
119. Zener diode works in ____________ bias

120. The energy gap when doped with a pentavalent impurity
a) increases b) decreases c) remains the same

121. In an n type semiconductor n_e/n_h is
a) <1 b) >1 c) =1

122. Electrical conductivity of a pure semiconductor at a given temperature depends
a) Width of forbidden band b) intrinsic charge carrier concentration. c) both d) none

123. Output in the following is a) 5V b) -5 V c) 0 V d) 1 V



124. Beyond zener breakdown voltage when current changes voltage
a) increases b) decreases c) no Change

125. In forward bias of junction diode width of depletion region
a) decreases b) increases c) does not change.

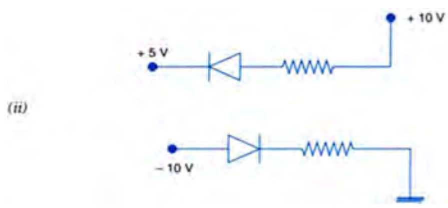
126. The conductivity of n- type semi conductor is __________ than p-type semiconductor though the concentration is the same of both the charges?

127. _____________ are prefered for fabrication of solar cells?

128. In a p-n jn diode, increase in forward voltage of 0.19 v increases forward current by 37.6 mA. dynamic resistance is ___________

129. A zener diode is specified havivg break down voltage of 9.1V with maximum power dissipation of 364mW. The maximum current the diode can handle is ____________

130. The diodes in figure are
a) both forward bias b) both reverse bias c) forward and reverse bias
d) reverse bias and forward bias



131. In half wave rectifier output power is ______%

132. In full wave rectifier output power is ______%

133. In insulators the forbidden energy gap is ____________

134. Pure Si at 300 K has equal electron and hole concentration of 1.5×10^{16} /m^3. Doping by Indium increases hole concentration to 4.5×10^{22}/m^3 electron concentration is ________

135. Drift current in a semi conductor is due to ___________________________________

136. Diffusion current in a semi conductor is due to

____

137. In intrinsic semiconductors ratio of electron hole concentration is

a) <1 b) >1 c) $=1$

138. In n-type semiconductor additional energy levels are formed _______________________

139. Voltage in forward bias of a p-n diode where current abruptly increas is

____

140. LED works in __________bias.

141. Hole concentration of a diode is the ratio of charge concentration to ______________

142. Maximum wavelength of electromagnetic radiationton to create electron-hole pair in silicon with band gap 1.1 eV is _____________

143. In a pure semiconductor number of conduction electrns is 6×10^{19} per m^3. How many holes are there in a sample of 1cm x 1cm x 2mm

144. Increase in tempature of a semiconductor _______ the forbidden gap

a) increases b) decreases c)will not change d)will double

145. Diamond behave like

a) conductor b) insulator c) semiconductor

146. Reverse bias of a pn jn diode

a) increases b) decreases c) will not change the barrier voltage

147. Piece of cu is cooled from room temparature to 80 k its resistance

a)increases b)decreases c)no change

148. When a reverse voltage of 5V is applied across the depletion region (thickness $< 10^{-6}$ m)of a Zener diode , find the field set up across the junction __________________

149. Solar cell works in ____________bias

150. The colour of light emited in LED depends on

a) Level of doping b) semiconductor used c) both d)none

ANSWER KEY OF OBJECTIVE / MCQ TYPE QUESTIONS FOR CLASS XII

ELECTRO STATICS

1. B

   Here, q+q' = Q, q'=Q-q , therefore $F = k\,qq'/r^2$

   $F=kq(Q-q)/r^2$

   For F to be maximum dF/dq = 0

   $\frac{d}{dq}\left[\frac{kq(Q-q)}{r^2}\right]=0$

   $\frac{d}{dq}\left[\frac{kqQ-k\,q^2}{r^2}\right]= 0$

   ∴kQ-2kq=0

   Or q=Q/2 and q'=Q/2 so q/q'=1

   Hence, answer is B
2. C

   Along X-axis
3. B

$$k = \frac{F_a}{F_m} \therefore F_m = \frac{F_a}{k} = \frac{8}{80} = \frac{1}{10}$$

4. D

$$\tau = pE\sin\theta$$

For the torque to be minimum, $pE\sin\theta = 0 \therefore \sin\theta = 0 or \theta = 0°$

5. A

   The equation signifies that the electric charges are algebraically additive and hence q_1 & q_2 are equal and opposite.
6. C

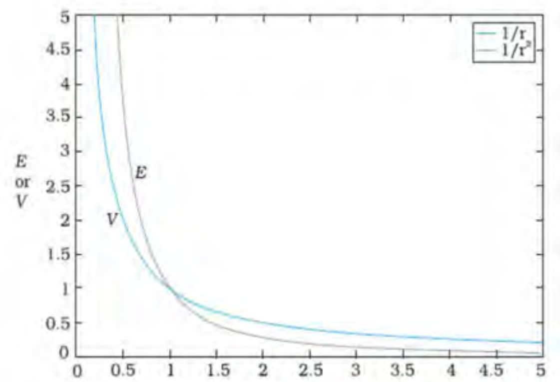
   Electric field is along X-axis as it should be perpendicular to equipotential surface which is in Y-Z plane
7. D
   a) Right- According to principle of superposition, force between two charges is not affected by the presence of other charges.
   b) Wrong- Potential due to a dipole is zero at equatorial line and not on axial line.
8. A

   angle between p and E must be 0^0
9. B

   The positive charge induced on the neck of the tube will accelerate the electron towards the neck.
10. A

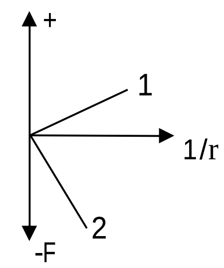
    They tend to move apart slightly due to polarisation of charges in them.

11. Electric dipole moment of an electric dipole is equal to the product of either charge or distance between the two charges.
12. The component of electric field along the tangent to the surface of the conductormust be zero.
13.



14. For given pair of charge $F \propto \frac{1}{r^2}$

Magnitude of q_1q_2 is higher and negative in second case.



15.

i) a) Charge produced on inner surface by induction = - q

Surface charge density on inner surface due to induction, $\sigma_i = \frac{-q}{4\pi R_1^2}$

An equal amount of charge +q is produced on outer surface

b) Charge on outer surface is = q + Q

Surface charge density on outer surface $\sigma_0 = \frac{q+Q}{4\pi R_2^2}$

ii) Electric field at a distance *x* (*x* > R_2) is

$E = k\frac{q+Q}{x^2}$ and is directed away from the conductor.

16.

+ Q charge is located at A(x_2, 0) and –Q charge is at B(x_1, 0)

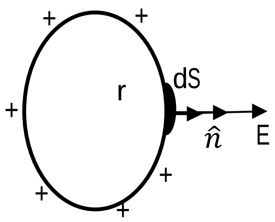
Electric Field at O due to + Q charge is $E_1 = k\frac{Q}{x_2^2}$ (Towards B)

Electric Field at O due to - Q charge is $E_2 = k\frac{Q}{x_1^2}$ (Towards B)

Net Electric Field at 'O' is $E = E_1 + E_2$ (Towards B)

$$E = kQ\left[\frac{1}{x_2^2} + \frac{1}{x_1^2}\right]$$

17. Let **q** charge be distributed uniformly on a surface of radius **r** Surface charge density $\sigma = \frac{q}{4\pi r^2}$



Electric field intensity on the surface of shell is

$$E = \frac{q}{4\pi \epsilon_0 r^2}$$

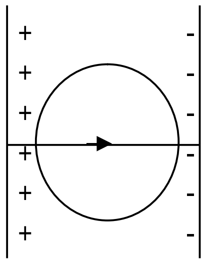
Or, $E = \frac{\frac{q}{4\pi r^2}}{\epsilon_0} = \frac{\sigma}{\epsilon_0}$

18.

Electric field is a vector quantity. In the first case, electric field at the center due to charges at A and due to C adds up and also due to charges at B and D is added up. There exists electric field at the centre. Whereas in the second case, field at the centre due to charges at A and C are equal and opposite and also due to B and D are also equal and opposite. So, the resultant field is zero.

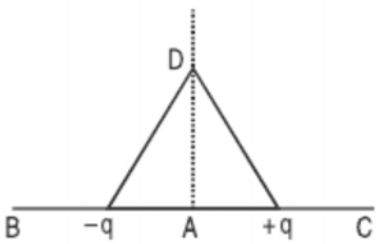
19. No, because within a metal the electric field is zero.

Therefore, no lines of force should exist between the spheres.



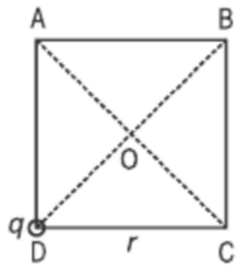
20. No, the force of attraction between spherical conductors will be more than (kq^2/d^2), due to attraction of opposite charges. These will be redistributed on spheres. Obviously, the effective distance between the charges will be reduced and hence effective force will be increased.

21.



At A & B, towards left. At C & D, towards right.

22.



$$\frac{2q}{4\pi\epsilon_0}$$

23. A and C in contact $q'_A = (q_A + q_C)/2 = 3.25 \times 10^{-7}$ C

This charge when in contact with C, $q'_{B} = (q_B + q'_A)/2 = 4.87 \times 10^{-7}$ C

New force = $\frac{1}{4\pi\varepsilon_0}\frac{q_A{'} - q_B{'}}{r^2} = 5.7 \times 10^3$ N

24. A proton has charge equal and opposite to that of an electron, hence

Force experienced by a proton = **-** Force experienced by an electron

25. It is defined as the electric force per unit positive charge acting on a vanishingly small test charge placed at that point.

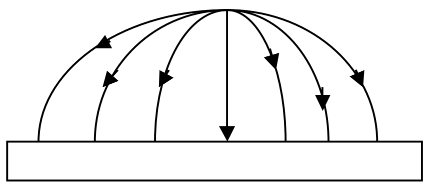
Its SI unit is N/C

26. Force decreases as F α 1/k

27. It is the product of either charge and the dipole length. Its SI unit is Cm.

28.

+Q



29. When the dipole is placed parallel to the non-uniform electric field.

30. By convention, the direction of electric field is the same as that of force on a unit positive charge. As this force is outward in the field of a positive charge, and inward in the field of a negative charge, so the directions are taken accordingly.

31. Not necessarily. The small test charge will move along the line of force only if it is a straight line. The line of force gives the direction of acceleration, and not that of velocity.

32. The charge on any body is always an integral multiple of e. Here

$n = q/e = 0.8 \times 10^{-19}$ C$/1.6 \times 10^{-19}$ C $= 0.5$

This is not an integer. So a body cannot have a charge of 0.8×10^{-19} C.

33. $\varepsilon = k\,\varepsilon_0 = 8.85 \times 10^{-12} \times 80 = 7.083 \times 10^{-10}$ C^2/Nm^2

34. When the charge involved is much greater than the charge on an electron, we can ignore its quantum nature and assume that the charge is distributed in a continuous manner. This is known as a continuous charge distribution.
35. It is defined as the ratio of the force between two charged placed some distance apart in free space to the force between the same two charges when they are placed the same distance apart in the given medium.
36. The electric field binds the atoms to neutral entity. Fields are caused by the excess charges. There can be no excess charge on the inner surface of an isolated conductor.
37. Final charge on sphere A is: $q_A/2$ and on sphere B: $(2q_B + q_A)/4$
38. In the static situation, there is no current inside, or on the surface of the conductor. Hence, electric field is zero everywhere inside the conductor.
39. Work done= - (electrostatic PE of system of these three charges)= 2.3×10^{-8}J
40. It indicates that
    i) Charge is so small in magnitude that it does not change the position of source charge.
    iii) It does not modify the electric field of the source charge.
41. (a)

$$\Phi = \oint \mathbf{E.ds} = Nm^2c^{-1}$$

42. (a)

$$\text{Flux density} = Q/\text{area} = Nm^2c^{-1}/m^2 = Nc^{-1}$$

43. (a)

$\epsilon = \epsilon_o k$, $\epsilon_o \longrightarrow$ *space or air permittivity*

44. (c)

q_1, q_2 are outside the Gaussian surface, only q_3 is inside the surface. i.e charge should be enclosed by the surface.

45. (b)

Net charge of the dipole is zero

$$\Phi = q/\epsilon_o = 0/\epsilon_o = 0$$

46. (d)

Total flux = q/ϵ_o. Charge is at the centre, electric flux is symmetrically distributed through all 6 faces.

Therefore, the flux linked with each face = $\Phi /6 = q/6\epsilon_o$

47. (b)

$E = \lambda /2\pi \epsilon_o r$, $E \propto 1/r$

48. (c)

$E = \sigma/2\epsilon_o$, ie E is independent of distance r

49. (a)

Charge inside the Gaussian surface shell is zero

$E.S = q/\epsilon_o = 0$

50. (b)

$\phi = q/\epsilon_o = 1/\epsilon_o = \epsilon_o^{-1}$ (i.e q=1)

51. (d)

$E = \sigma/\epsilon_o$ both charged spheres have same surface charge density $\sigma_1 = \sigma_2$

Therefore $E_1 : E_2 = 1 : 1$

52. (a)

Sphere enclosed -2q and q charges

Net charge = -2q + q = -q

Therefore $\Phi = - q/\epsilon_o$ or q/ϵ_o inwards

53. (a)

$E = \lambda /2\pi \epsilon_o r$, $\lambda = 2 \pi \epsilon_o r E = 10^{-7} cm^{-1}$

54. (a)

Electric field in between the plates

$\mathbf{E} = \sigma /\epsilon_o = 17x10^{-22}/8.85 x10^{-12} = \mathbf{1.9} \times 10^{-10} Nc^{-1}$

55. (a)

$\bar{E} = 8\mathbf{i}+4\mathbf{j}+3\mathbf{k}$ and $S = 100\mathbf{k}$

$Q_e = E.S = 300\ Nm^2c^{-1}$

56. (b)

Charge enclosed is the same.

Flux is independent of the size or shape of the Gaussian surface.

57. (b)

$E = q/4\pi \epsilon_o r^2$ $(r>R)$

Where R is the radius of the Gaussian surface

$E = 0.2x10^{-6}x9x10^9 / 3^2$

$E = 200\ Nc^{-1}$

58. (b)

Total flux $\Phi = q/ \epsilon_o$

Through hemisphere = $q/2\epsilon_o$

59. (c)

$\sigma = q/A \implies q = \sigma A$

$q_1 = \sigma 4 \pi R_1^2$, $q_2 = \sigma 4 \pi R_2^2$

$q_1 : q = 1:4$ (i.e $R_1=R$, $R_2=$ **2R**)

60. (b)

$\Delta \Phi = q/\epsilon_o$, $q = \Delta \Phi \epsilon_o$

$q = [3000-5000]\ 8.85\times 10^{-12}$

$q = 1.77\times10^{-8}C$

61. (a)

Total flux $\Phi = q/\epsilon_o = 17.7x10^{-6}/8.85x10^{-12} = 2\times10^6$ $Nc^{-1}m^2$

Flux density $\Phi = Q/A = Q/4\pi r^2 = 2\times10^6 / 4\times3.14\times(0.5)^2 = 6.4\times10^5$ Nc^{-1}

62. (c)

Φ =EScosθ , θ is the angle in between $\bar{E}$ and normal to the surface area(sň)

but the angle between the plane sheet and $\bar{E}$ is 60°

θ =90°-60°=30°

$\Phi = EScos\theta = E\pi r^2 cos\theta$

$\Phi = 5x10^5$ x 3.14 x $(0.1)^2cos30°$

$\Phi = 1.36\times10^4$ Nm^2c^{-1}

63. (c)

Total flux = q/ϵ_o ,

Flux through each face = $q/6\epsilon_o$,

Flux through 2 opposite faces = $q/6\epsilon_o + q/6\epsilon_o$

$= q/3\epsilon_o$

64. (b)

Inside a charged conducting surface E=0, but on the surface E≠0.

∴ Electric field intensity is discontinuous across a charged conductor.

65. (d)

Value of electric field is well defined at every point on Gaussian surface

66. (b)

Thick conducting sheets carry charge on both sides with the same surface charge density σ.

$E = (\sigma/\epsilon_o) + (\sigma/\epsilon_o) = (2\sigma/\epsilon_o)$

67. (c)

$\Phi = Edscos\theta$

Area of the point ds=0

∴ Φ=0

68. (d)

Φ= Edscosθ

Cosθ value may be positive, negative or zeros based on the value of θ.

69. (d)

Φ= Edscosθ

Surface area of hemisphere ds= $2\pi r^2$ and θ= 0°, cos0=1

$\therefore \Phi = 2\pi r^2 E$

70. (a)

Φ= Edscosθ, θ=90°

$\therefore \Phi=0$

71. (c)

The closed surface integral of electric field is electric flux

72. (d)

$E = (\sigma/\epsilon_o) - (\sigma/\epsilon_o) = 0$

No field in the space outside the sheets

73. (a)

Negative sign indicates that the field lines are moving towards the charge

74. (a)

$E= \sigma / \epsilon_o = q/A\epsilon_o$, where A =unit

$\therefore E= q/\epsilon_o$

75. (c)

Net charge for 8 dipoles q=0

$\Phi= q/\epsilon_o =0$

76. (a)

R/2 < R i.e inside the spherical shell E=0

77. (c)

Total flux entering the surface is equal to the total flux leaving the surface. So net flux associated with the surface is zero.

78. (c)

$$\Phi = \oint \mathbf{E}.\mathbf{ds} = 0$$

$\therefore \Phi=0$

79. (a)

$$\Phi = \mathbf{E}.\mathbf{S} = \{(5\mathbf{i} + 4\mathbf{j} - 4\mathbf{k}) \times 10^5\} . \{(2\mathbf{i} - \mathbf{j}) \times 10^{-2}\}$$

$$\Phi = (10\text{-}4\text{-}0)\, 10^3 = 6 \times 10^3\ Nm^2C^{-1}$$

80. (c)

Outside charge is not contributing flux (or) Gauss theorem includes only the charge is enclosed by the closed loop

Electric Potential and Capacitance

1. ANSWER (1): Electrostatic field is a conservative field.
2. ANSWER (2): integral of force function in the limits P to R

   $= \int_P^R F(x)dx$=U (P) – U(R) = dU .

   It is defined as amount of work required to transport the charge from point R to P along any path in the electrostatic field of charge Q or q.

3. ANSWER (3): integral of force function in the limits P to Infinity

   $= \int_P^\infty F(x)dx$=U (P) – U (infinity) = U.

   It is defined as amount of work to be done to transfer a test charge q from infinity to point P along any path in electrostatic field of charge Q. Here charge Q is called or defined as source charge.

4. ANSWER (4):Potential difference (V) in an electrostatic field or in a circuit is defined asdifference of potentials. It is also defined as amount of work to be done to transfer unit positive charge in-between two given points in an electrostatic field or in a circuit.
5. ANSWER (5): Both electric potential & potential difference are scalars as basically they are works done.
6. ANSWER (6): Definition volt(V):- Volt is S,I. Unit of electrostatic potential and potential difference(v) in an electrostatic field or electric circuit and is defined as that electrostatic potential and potential difference(v) developed in an electrostatic field or electric circuitWhich requires one joule of work to transfer unit positive

charge or one coulomb of charge In between two given points in an electrostatic field or electric circuit.

7. ANSWER (7): $[V] = [M^1 L^2 T^{-3} A^{-1}]$
8. ANSWER (8): $v=Q/4\pi\epsilon_0 r$
9. ANSWER (9): Positive charge produces positive potential & negative charge produces negative potential.
10. ANSWER (10): principle of superposition of electric potentials: statement:

According to principle of superposition of electric potentials, electric potential at a point due to number of charges is equal to algebraic sum of all the potentials acting at that point due to all charges, taken one at a time. I.e. the individual potentials are not affected by the presence of other charges. I.e. charges preserve their individuality.

11. ANSWER (11): $V= p\cos\Theta / 4\pi\epsilon_0 r^2$ along axial line & along equatorial line.
12. ANSWER (12): $v=Q/4\pi\epsilon_0 r$
13. ANSWER (13): $v=Q/4\pi\epsilon_0 r$, outside shell, r is the distance measured from the centre of shell &

$v=Q/4\pi\epsilon_0 R$, where R is radius of spherical shell, constant inside shell & on the spherical shell.

14. ANSWER (14): Definition of the term equipotential surface:-

Equipotential surfaces are two dimensional surfaces over which potential are constant for three dimensional problems.

15. ANSWER (15): zero
16. ANSWER (16): zero
17. ANSWER (17): $E=-dv/dl$ (or) $E=-dv/dr$.
18. ANSWER (18): If equipotential surfaces are closer(crowded) electric field in that region is strong. If equipotential surfaces are not closer(not crowded) electric field in that region is not strong(weak). I.e. the relative concentration of equipotential surfaces gives us relative strength of Electric fields .
19. ANSWER (19): E=QV
20. ANSWER (20): E=QV
21. ANSWER (21): $E = Q_1 v_1 + Q_2 V_2 + Q_1 Q_2/4\pi\epsilon_0 r$,where r is distance between charges.
22. ANSWER (22): $U=PE\cos\Theta=\bar{P}.\bar{E}$
23. ANSWER (23): When $\Theta=0$(zero), i.e. when dipole axis is in the direction of electric field direction, the electric dipole is in stable equilibrium.
24. ANSWER (24): When $\Theta=180^0$, i.e. when dipole axis is in the direction opposite to that of electric field direction, the electric dipole is in unstable equilibrium.

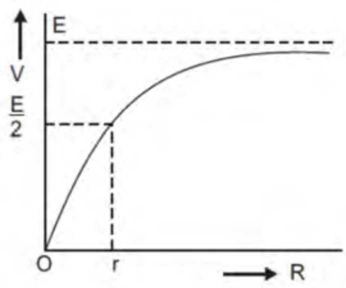
25. ANSWER (25):The earth is always at zero potential.
26. ANSWER (26): The potential of earth is taken as zero always because the earth neutralizes any charged on its surface.
27. ANSWER (27): Dielectric reduces the electric potential produced by a charge .
28. ANSWER (28): $Ev=1.6x10^{-19}j$.
29. ANSWER (29):potential difference(P.D,V)
30. ANSWER (30): DEC (K) $=V_0$ (Potential in air)/V (potential in medium)
31. ANSWER (31): [B]
32. ANSWER (32): [D]
33. ANSWER (33): [D]
34. ANSWER (34): [A]
35. ANSWER (35): [D]
36. ANSWER (36): 6(SIX)
37. ANSWER (37): SPHERES CENTRED ABOUT THE GIVEN CHARGE
38. ANSWER (38):planes perpendicular to the direction of electric field.
39. ANSWER (39): never
40. ANSWER (40): decreases
41. Dielectric strength
42. 1.78×10^{-8}
43. K=12
44. $R=9\times10^{3}m$ =9km
45. 4μF
46. Dielectrics are nonconductors and do not have free electrons at all. While conductors have free electrons which make it able to pass the electricity through it.
47. Dielectric constant: it is defined as the capacitance with dielectric in medium to the capacitance with vacuum. It is also defined as the ratio of the permittivity of the material to the permittivity of free space. It has no unit. The mathematical formula for the dielectric constant is $k = \varepsilon / \varepsilon_o$
48. Line B corresponds to C_1 because slope (q/V) of B is less than slope of A.
49. C decreases.
50. Capacitance of parallel plate capacitor will become infinite
51. $Q^2 / 8\pi g\varepsilon_\circ\times(1/a-1/b)$

52. **Polar Dielectrics:** Polar dielectrics are those in which the possibility of center coinciding of the positive as well as negative charge is almost zero i.e. they don't coincide with each other. The reason behind this is their shape. Examples of the polar dielectrics are NH_3, HCL, water etc. **Non Polar dielectrics:** In case of non-polar dielectrics the centers of both positive as well as negative charges coincide. Dipole moment of each molecule in non-polar system is zero. All those molecules which belong to this category are symmetric in nature. Examples of non-polar dielectrics are: methane, benzene etc.
53. For this, the instrument must be enclosed fully in a metallic cover. This will provide an electrostatic shielding to the instrument.
54. The body of a car is metallic. It provides electrostatic shielding to the person in the car, because electric field inside the car is zero. The discharging due to lighting passes to the ground through the metallic body of the car.
55. Potential functions do not have a maximum or minimum in free space.
56. Because of ionization caused by the highly energetic cosmic ray particles from cosmos.
57. Because:
    a. Water molecules have a symmetrical shape as compared to mica.
    b. Water molecules have a permanent dipole moment.
58. Work done is 0.
59. Zero.
60. Zero.
61. High potential.
62. Protons moves from high potential to lower potential. Thus potential energy decreases.
63. Zero.
64. Parallel plate capacitor. It is used to store electrostatic energy.
65. Increases
66. c) both (a) and (b)

67. c) When the battery is disconnected, the charge on the capacitor plates remains the same.
68. d)6
69. b)66.6%
70. a) k C/(1+k)
71. b)5 μF
72. d)1.25J
73. b)1/2×n×C× V^2
74. b)U/2
75. d)4W
76. b)0.5)Increases
77. b)The potential difference increases
78. c)3m
79. When a dielectric is inserted in an external electric field the positive and negative centers of charge are pulled by the negative and positive ends of external field, thus creating an induced dipole moment and this phenomenon is known as polarization of dielectric.

CURRENT ELECTRICITY

Q. No.	**Expected Answers**
1	ohm metre
2	B (In parallel the effective resistance will be less and V/I value also be less)
3	The electron number density is of the order of 10^{29} m^{-3}. That's why the net current can be very high even if the drift speed is low.
4	Nichrome is preferred because its resistivity is higher and causes more heating effect.
5	Meter Bridge and post office box.
6	2 ohm 3 and 3 are in series and parallel with 6 ohm. Resultant gives again 3 ohm. In ACB closed loop 3 and 3 are in series and parallel with 3 ohm. Which gives resultant as 2 ohm.

7	No. because resistance is directly proportional to the length of the wire. When you bent or reorient, its length will not change.
8	Wheatstone bridge principle.
9	The amount of current flowing per unit cross – sectional area of a material. It is a vector.
10	Drift velocity would decrease with increase in temperature because kinetic energy of electrons increases and they undergo more collisions.
11	Mobility may be defined as the drift velocity per unit electric field. SI Unit: m^2 / V.sec
12	I = $\frac{E}{r+R}$ = 0.5A
13	I = $\frac{E}{r+R}$ = 0.5A. V = E – IR = 1.95 V
14	$\rho = R\frac{A}{l} = R\frac{\pi D^2}{4l} = 2\times\frac{3.14\times(0.4\times10^{-3})^2}{4\times1} = 2.5\times10^{-7}\,\Omega m$
15	Terminal potential difference, $V = IR = \left(\frac{E}{R+r}\right)R = \frac{E}{1+\frac{r}{R}}$ When $R \to 0, V = 0$ When $R = r, V = \frac{E}{2}$ When $R = \infty, V = E$ The graph is shown in fig. 
16	When length of a given wire is made n-times by strecting it, its resistance becomes n^2 times *i.e.*, $R' = n^2 R = (2)^2 \times 15 = 60\ \Omega$ Resistance of each half part = $\frac{60}{2} = 30\ \Omega$ When both parts are connected in parallel, final resistance = $\frac{30}{2} = \mathbf{15\ \Omega}$ Current drawn from battery, $I = \frac{V}{R}$ $= \frac{3\cdot0}{15} = \mathbf{0\cdot2\ A}$
17	R = $\frac{V^2}{P}$ ⇒ R α $\frac{1}{P}$. The bulb marked 25W has higher resistance than the bulb marked 100W.

18	$\alpha = \frac{R_2 - R_1}{R_1(T_2 - T_1)} \Rightarrow \alpha = \frac{2.7 - 2.1}{2.1(100 - 27.5)} = 0.0039^0 C^{-1}$
19	a)Total resistance, $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{2} + \frac{1}{4} + \frac{1}{5} = \frac{19}{20}\Omega \Rightarrow R_P = \frac{20}{19}\Omega$ (b) Current drawn from the battery $I = \frac{E}{R_P} = \frac{20}{\left(\frac{20}{19}\right)} = 19A$
20	R = 60 x $10^4 \Omega$ and $I = \frac{V}{R} = \frac{30}{60 \times 10^4} = 0.5 \times 10^{-4} A = 0.05 mA$

21	22	23	24	25	26	27	28	29	30
B	A	C	C	D	A	D	B	B	C
31	32	33	34	35	36	37	38	39	40
B	C	A	D	D	C	D	D	B	C

Q.No.	Answer Key
41.	3
42.	1
43.	4
44.	3
45.	2
46.	4
47.	2

48.	3
49.	4
50.	2
51.	3
52.	3
53.	3
54.	2
55.	2
56.	1
57.	2
58.	4
59.	4
60.	2
61.	1
62.	2
63.	2
64.	1
65.	4
66.	2
67.	3

68.	1
69.	1
70.	1
71.	2
72.	3
73.	4
74.	1
75.	2
76.	1
77.	1
78.	4
79.	3
80.	2

MANGETIC EFFECTS OF CURRENT AND MAGNETISM

1. The magnetic field at a point due to an element of current is
   i) Directly proportional to the current
   ii) Directly proportional to the length of the wire
   iii) Directly proportional to the sine if the angle subtended by the elementary wire to the line joining the element of the wire to the observation point.
   iv) Inversely proportional to the square of the distance from the point.
2. $d\vec{B} = \frac{\mu_0}{4\pi} \frac{Id\vec{l} x \vec{r}}{r^3}$
3. tesla: One tesla is 10^7 times the magnetic field produced by a conducting wire of length one metre and carrying a current of one ampere at a distance of one metre from it and perpendicular to it.

4. B = $\frac{\mu_0 I}{2r}$
5. The magnetic field at the center of a current carrying coil depends on the current flowing through the coil and the radius of the coil.
6. Right hand thumb rule: I we curl the palm of our right hand around the circular wire with the fingers pointing in the direction of the current, then the extended thumb gives the direction of the magnetic field.
7. Ampere circuital law states that the line integral of the magnetic field $\vec{B}$ around any closed circuit is equal to μ_0 times the total current 'I' threading through the closed circuit.
$$\oint \vec{B}.\vec{dl} = \mu_0 I.$$
8. B = $\frac{\mu_0 I}{2\pi r}$
9. A solenoid is an insulated copper wire wound closely in the form of a helix.
   B = μ_0 nI
10. Fleming's left-hand rule: Stretch the thumb and first two fingers of the left hand mutually perpendicular to each other. If the forefinger points in the direction of magnetic field, central finger in the direction of the current then the thumb gives the direction of the force on the charged particle.
11. Lorentz force is the total force experienced by a charged particle moving in a region where both electric and magnetic fields are present. $\vec{F}$ = q ($\vec{E}$ + $\vec{v}$X$\vec{B}$)
12. $\vec{F}$ = q ($\vec{v}$X$\vec{B}$)
13. Magnetic field.
14. When an electron is moving in a direction perpendicular to that of the magnetic field.
15. When the charge is moving in the same direction or opposite direction to the field.
16. Along the direction of ($\vec{v}$X$\vec{B}$).
17. Circular path.
18. Alpha and beta radiations are deflected by the magnetic field.
19. Along the z-axis.
20. Magnetic field is along the negative z-axis.
21. As F = qvb and charge q on alpha particle is double than that of beta particle but speed v is same. Hence the force on alpha particle will be double than that of beta particle.
22. B = μ_0 nI = 4π x 10^{-7} x 300 x 5 = 1.9 x 10^{-3}T.
23. Either there is no magnetic field or the electron is moving parallel or anti parallel to the direction of the magnetic field.
24. Work done is zero because ϴ is 90^0 and W = Fdl cos 90^0 = 0.
25. TmA^{-1}.
26. $10^7 T^{-1}m^{-1}A$.
27. Cyclotron is a device which is used to accelerate charged particles like protons, deuterons, alpha particles etc to very high energies.

28. A charged particle can be accelerated to very high energies by making it pass through a moderate electric field n number of times. This can be done with the help of a perpendicular magnetic field which throws the charged particle into a circular motion, the frequency of which does not depend on the speed of the particle and the radius of the circular orbit.
29. The function of the electric field is to accelerate the charge.
30. The function of magnetic field is to make it to pass through electric field a number of times.
31. No, because neutrons being electrically neutral cannot be accelerated in a cyclotron.
32. Answer
33. The mass of the electrons is very small, they are accelerated very fast and go out of the range very quickly.
34. $r = \frac{mv}{eB}$ so, r α mv. Therefore $r_e : r_p = 1:1$
35. Cyclotron frequency depends on the charge of the particle, magnetic field and the mass of the charged particle.
36. The high energy particles produced in a cyclotron are used to bombard nuclei and study the resulting nuclear reactions.
37. $\mu_0 \epsilon_0 = \frac{1}{c^2}$
38. s^2m^{-2}.
39. Zero, because the observation point lies on the axis of the straight conductor.
40. Towards west.

41.		42.		43.		44.	
45.		46.		47.		48.	
49.		50.		51.		52.	
53.		54.		55.		56.	
57.		58.		59.		60.	
61.		62.		63.		64.	
65.		66.		67.		68.	
69.		70.		71.		72.	
73.		74.		75.		76.	
77.		78.		79.		80.	

MAGNETISM AND MATTER

1. d
2. c
3. a
4. No
5. Yes. Its length increases.
6. Non-magnetic material.
7. a
8. a
9. C
10. C
11. a
12. toroid
13. No.
14. b
15. Mono-pole does not exist.
16. b
17. b
18. c
19. d
20. a
21. c
22. a
23. b
24. c
25. d
26. a
27. a
28. c
29. c
30. a
31. $\vec{\tau} = \vec{M} \times \vec{B}$
32. b
33. b
34. b
35. a
36. c
37. b

38. (a) 0^0 and (b) 90^0
39. 154 J/T
40. a
41. C
42. A
43. A
44. C
45. A
46. A
47. B
48. D
49. B
50. B
51. A
52. D
53. D
54. B
55. D
56. D
57. D
58. C
59. A
60. C

FILL IN THE BLANKS :-

61. High, low.
62. Decreased.
63. Diamagnetic.
64. 2/3 A/m.
65. Al and Na.
66. Copper and Bismuth.
67. Al and Ca.
68. Curie.
69. Para and Ferro.
70. No.
71. Diamagnetic.
72. Zero.
73. Diamagnetism.

74. Super conductors.
75. Meissner.
76. Paramagnetic.
77. Ferromagnetic.
78. Cu.
79. Soft.
80. Lagging behind.

ELECTROMAGNETIC INDUCTION

Q.NO.	KEY	EXPLANATION
1.	d	The resistance of the coil
2.	a	$\phi = 5t^3 - 100t + 300$ $\mathcal{E} = -\frac{d\phi}{dt} = -(15t^2 - 100)$ At $t = 2s$, $\mathcal{E} = -(60 - 100) = \mathbf{40\ V}$.
3.	c	Energy
4.	a	By right hand rule, the magnetic flux of the current in the wire PQ acts on the loop in a direction perpendicular to the plane of the paper and outwards. By Lenz's law, the induced current should oppose the increase of flux i.e. it should produce inward flux. So the induced current flows in the clockwise direction.
5.	a	By right hand rule, the magnetic field of the current in wire AB acts on the loop in a direction perpendicular to the plane of paper and inwards. By Lenz's law, the induced current should oppose the decrease in flux, i.e., it should also produce inward flux. So the induced current flows in the clockwise direction.
6.	b	When seen from the magnet side, the induced current flows anticlockwise in the loop. The face of the loop towards the magnet develops N-polarity and gets repelled away from the magnet.
7.	b	The induced current is set up in the coil because the magnetic flux linked with it changes when the magnet is moved. As the induced e.m.f. opposes its cause, the induced current flows clockwise when the N-pole is moved towards the coil and induced current flows anticlockwise when the magnet is moved away from the coil (when seen from the magnet side).
8.	a	When N-pole of the magnet is moved towards the loop, current is induced in the anticlockwise direction when seen from the magnet side. So the plate A has +ve polarity and the plate B have –ve polarity.
9.	c	According to Fleming's left hand rule, the free electrons experience magnetic force in the direction from A to B. Deficit of electrons makes end A positive while excess of electrons makes end B negative.

10.	b	Zero, because the flux linked with the loop KLMN due to the steady current in PQ is not changing.
11.	a	Zero. No e.m.f. is induced in the coil because there is no net change in the flux linked with the coil.
12.	d	By Lenz's law, the ends of both the coils closer to the magnet will behave as south poles. Hence the current induced in both the coils will flow clockwise when seen from the magnet side.
13.	a	The magnetic lines of force due to the current I are parallel to the plane of the loop. The flux linked with the loop is zero. Hence no current is induced in the loop.
14.	c	The magnetic lines of force due to the current in conductor B will be parallel to the plane of conductor A. The magnetic flux linked with the conductor A is zero. So no current is induced in the conductor A.
15.	d	When switch S is closed, the current I_p sets up a magnetic field around P which also passes through Q. By Lenz's law, the induced current I_{Q1} flows anticlockwise when seen by E. When switch S is opened, the current I_{Q2} flows clockwise.
16.	c	As the cylinder is kept stationary and also the magnetic field is uniform, the flux linked with the cylinder is not changing. So no current is induced in the cylinder.
17.	b	Induced emf, $\varepsilon = -\frac{d\phi}{dt}$ Induced current, $I = \frac{\lvert\varepsilon\rvert}{R}$ $\frac{dq}{dt} = \frac{1}{R}\frac{d\phi}{dt}$ $dq = \frac{1}{R}d\phi$ $\int dq = \frac{1}{R}\int d\phi$ $q = \frac{\phi}{R} = \frac{BA}{R}$.
18.	b	As the magnet approaches the solenoid, the magnetic flux linked with the solenoid increases. Induced e.m.f. is negative. The magnitude of e.m.f. increases as more and more length of the magnet goes into the solenoid. The increase in φ_B slows down and induced e.m.f. decreases. The e.m.f. becomes positive as the magnet leaves the coil. Only in option (b), the polarity is changing.
19.	b	The emf induced in the coil, $\varepsilon = -n\frac{d\phi}{dt} = -n\frac{\phi_2 - \phi_1}{t}$

		Total resistance, $$R' = R + 4R = 5R\,\Omega$$ Induced current, $$I = \frac{\varepsilon}{R'} = -\frac{n(\phi_2 - \phi_1)}{5Rt}$$
20.	c	Electromagnetic induction
21.	d	Here, area $A = \left(\frac{10}{100}\right)^2 = \frac{1}{100}\ \text{m}^2$ $$\varepsilon = NA\frac{dB}{dt} = 500 \times \frac{1}{100} \times 1\text{V} = 5\ \text{V}$$
22.	b	$$\lvert\varepsilon\rvert = \frac{d\phi}{dt} = \frac{d}{dt}(\pi r^2 B) = \pi B\frac{d}{dt}(r^2)$$ $$= \pi B \times 2r\left(\frac{dr}{dt}\right) = 2\pi r B\left(\frac{dr}{dt}\right).$$
23.	a	$$\phi = 5t^2 + 3t + 16$$ $$\varepsilon = \frac{d\phi}{dt} = 10t + 3$$ At $t = 3$ s, $$\varepsilon_3 = 10 \times 3 + 3 = 33\ \text{V}$$ At $t = 4$ s, $$\varepsilon_4 = 10 \times 4 + 3 = 43\ \text{V}$$ The emf induced in fourth second $$= \varepsilon_4 - \varepsilon_3 = 43 - 33 = 10\ \text{V}.$$
24.	c	Weber
25.	c	Faraday's Law
26.	a	$[ML^2T^{-2}Q^{-1}]$
27.	b	As the magnet rotates, its N – pole moves closer to coil CD and S – pole moves closer to coil AB. By Lenz's law, N – pole develops at end near C. So induced current flows from C to D. Also, S – pole develops near end B. So, induced current flows from B to A.
28.	c	φ = NBA Cos θ i.e., $\varphi \propto$ N
29.	c	$$\varepsilon = -\frac{\phi_2 - \phi_1}{t}$$ $$125 \times 10^{-3} = -\frac{0 - 1 \times 0.5 \times 0.5 \times \cos(90° - \theta)}{0.1}$$ $$125 \times 10^{-3} = 0.50 \times 0.50 \times \sin\theta$$ $$\sin\theta = \frac{125 \times 10^{-3}}{0.50 \times 0.50} = \frac{1}{2}$$ $$\theta = 45°.$$

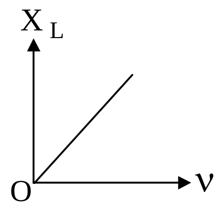
30.	d	Field at the centre of the ring, $B = \frac{\mu_0 I}{2R} = \frac{\mu_0 q}{2RT} = \frac{\mu_0 q f}{2R}$
31.	c	$\varepsilon = -NA\frac{B_2 - B_1}{t}$ $0.1 = -50 \times 100 \times 10^{-4} \frac{0 - 2 \times 10^{-2}}{t}$ $t = \frac{10^{-2}}{0.1} = \mathbf{0.1\ s.}$
32.	a	$\varepsilon = Blv$ $= 4 \times 10^{-5} \times 35 \times 90$ $= 126 \times 10^{-3}\ V = \mathbf{0.126\ V.}$
33.	b	$\phi = B\pi r^2 \cos 0° = B\pi r^2$ $\lvert\varepsilon\rvert = \frac{d\phi}{dt} = \frac{d}{dt}(\pi r^2 B) = 2\pi r B \frac{dr}{dt}$ When $r = 2\ cm = 2 \times 10^{-2} m$, $\frac{dr}{dt} = 1\ mm\ s^{-1} = 10^{-3} ms^{-1}$ $\lvert\varepsilon\rvert = 0.025 \times \pi \times 2 \times 2 \times 10^{-2} \times 10^{-3}$ $= 0.100 \times \pi \times 10^{-5} = \pi \mu V.$
34.	b	As the magnet falls, the magnetic flux linked with the ring increases. This induces e.m.f. in the ring which opposes the motion of the falling magnet. Hence a < g.
35.	a	When the induced current flows anticlockwise, it opposes the motion of N – pole of the magnet as per Lenz's law.
36.	b	Direction of induced e.m.f. changes after every half revolution. i.e., twice per revolution.
37.	d	Clockwise in ring 1 and anticlockwise in ring 2
38.	c	Induced current flows clockwise in the metal ring.
39.	a	$[ML^2A^{-1}T^{-2}]$
40.	c	By Lenz's law, the direction of induced current will be such that it tends to maintain the original flux. So induced current flows anticlockwise in loop 1 and clockwise in loop 2.

41.	D	42.	C	43.	D	44.	A	45.	D
46.	B	47.	B	48.	D	49.	A	50.	C

51.	B	52.	D	53.	C	54.	C	55.	B
56.	D	57.	B	58.	B	59.	C	60.	C
61.	D	62.	B	63.	A,B,D	64.	A,B,C	65.	A,D
66.	B,C								

67. There is no effect on inductance of solenoid in dc . Therefore brightness of the bulb does not change.
68. Due to eddy current setup in the core the Galvanometer oscillates
69. Induced emf in both the loops is the same but induced current is more in cu because the resistance of cu is lesser .
70. Electric brakes
71. There is no effect on inductance of solenoid in dc . Therefore brightness of the bulb does not change

ALTERNATING CURRENT

Q.NO.	Ans (Option)	Solution / Hint
1.	3	$X=V^2/R$, $V_{rms}=V=V_0/\sqrt{2}=10$ V $V'^2/R=X/2$, therefore, $V_0'=V'\sqrt{2}=V=10V$
2.	1	
3.	2	As voltage is leading current by 45^0, inductive reactance is equal to resistance of the inductor. $X_L=100ohm$ on simplification $L=1/20\pi$
4.	3	$P=I_0V_0\cos\phi$, here $I_0=V_0=100$, $\phi=\pi/3$. P=2.5W
5.	3	It's magnetic field
6.	1	In resonance $X_C=X_L=60$, $L=60/\omega=60/2\pi100=0.1H$
7.	3	I=V/R= 300/10 = 30 A
8.	2	$V = 10 \sin \omega t = 5\sqrt{3}$ V
9.	2	$\omega>\omega_0$, at this frequency circuit behave more inductive, so the current lags voltage.
10.	2	$P_C=P^2R/V^2$, it is more economical due to less power loss
11.	2	$I_{rms}=I_0/\sqrt{2}$
12.	2	Power factor $\cos \phi = R/Z = R/\sqrt{(R^2+X^2)} = 3 / 5 = 0.6$
13.	3	$L_1C_1=L_2C_2$, $L_2= L_1C_1/ C_2=L/4$
14.	3	$X_L= \omega L=314$

		$I_0=V_0/X_L=1$ A (approx.)
15.	1	Zero, as there is no induced emf across the coil in DC
16.	4	R=V/I=100 ohm, $X_L=\surd(Z^2-R^2)=30000$ L=√0.3 H
17.	3	$X_L=\omega L=75.4$ ohm
18.	3	$V_0=I_{rms}\surd2\ R = 5\surd2\ 24 = 170$ V
19.	1	$V^2=\surd(V_R^2+V_L^2)$, $V_L=\surd(V^2-V_R^2)=160V$
20.	2	$I_0=V_0\omega C=22$, $I_{rms}=I_0/\surd2=11\surd2A$
21.	2	In purely resistive circuit current is in phase with emf
22.	3	$\omega=120$, $\nu= \omega/2\pi=19Hz$ $V_{rms}=V_0/\surd2=240/\surd2=170V$
23.	3	$V_{rms}=V_0/\surd2=707/\surd2=500V$
24.	1	For resonance frequency to be constant LC= const $L_1C_1=L_2C_2$ $C_2=LC/(L/2)=2C$
25.	1	$X_L=\omega L$, $\omega= X_L/L=1/10^{-3}=10^3$
26.	4	$X_c= 1/\omega C=1/(2\pi50)C=10^{-2}$
27.	2	In ac circuit, as the total emf if the vector sum of voltages, so in ac circuits it is possible to have more pd across an element than the source emf
28.	2	$I_{rms}=5$, $I_0=5\surd2$
29.	2	$Z=\surd(R^2+X_L^2) = \surd(3^2+4^2)=5$
30.	4	As the current reaches steady state, there will be no back emf and the circuit will be shorted through inductor. So bulb only glows till current reaches steady state then it turns off.
31.	2	-90^0 (as voltage leads current in an inductor circuit)
32.	1	E=-L dI/dt = -5(-2) = 10V
33.	1	$\nu=1/2\pi\surd LC = 10^5/\pi$
34.	2	$I_{rms}=I_0/\surd2=2/\surd2=\surd2$
35.	2	$I_{rms}=V_{rms}/R=V_0/\surd2R=1.44$
36.	4	E=158 Sin200πt on substituting t=1/400s E=158 Sin π/2 = 158V
37.	3	E=100Cos(ωt+π/3), I=4Sin(ωt)=4Cos(ωt-π/2) Now the phase difference between E and I=π/2-(-π/2)=5π/6
38.	1	Current should be alternating
39.	2	100 times. As current becomes zero for two times in every single cycle.
40.	4	Voltmeter reads r.m.s. value of voltage

41. Ans:a

42. Ans :a

Solution: $R = \frac{V^2}{P} = \frac{220V^2}{100W} = 484\Omega$

The peak voltage of the source is $vm = \sqrt{2}$ V= 311V

P=IV; I=P/V=$\frac{100W}{220V}$=0.450A

43. Ans:c

Sol: Power in ac circuit, P= VI cosø.Here ø=π/2=90◦.∴ P=VI cos90◦=V X IX0=0

44. ANS : B

solution: P=EI cosø and cosø=1, we have P=EI or I= $\frac{P}{E}$

case I at 220V I_1= $\frac{11000}{220}$ 50A

Case II at 22000V, I_2=$\frac{11000}{22000} = 0.5A$

Current in case I is 100 times more than in case II, resulting into $I^2\ R\ loss\ to\ be$ 10000 $times.$

clearly case ii is preferred

45. a ; $XL = XC$, Current is in phase with voltage

46. c

Sol:$P = \frac{V^2}{R}$; R=$\frac{V^2}{P}$ =$\frac{220^2}{100}$ =484 Ω

I_{rms}=$\frac{V}{R} = \frac{220}{484}$=0.45A

47. 0.01A

S0l: Current drawn by secondary I_s=$\frac{Vs}{Z}$=$\frac{22}{220}$0.1A

Using $\frac{Vp}{Vs} = \frac{Is}{Ip}$ we get $Ip = \frac{VsIs}{Vp}$=$\frac{22X0.1}{220}$= 0.01A

48. a

Sol:At resonance i.e., when $XL = Xc$ i.e., when $\omega L = \frac{1}{\omega C}$

We get $\omega = \frac{1}{\sqrt{LC}}$ =$\frac{1}{\sqrt{L0.405\ X\ 25\ X\ 10^{-6}}}$=314 rad/s

49. a :Curve-I

50. a :$\frac{es}{ep} = \frac{Ns}{Np} = \frac{Vs}{Vp} = \frac{ip}{is}$=k Transformation ratio

51. d ; LCR circuit only

52. a ; AC generator
53. b ; Resistive , 0◦
54. a; Ø=$\tan^{-1}(\frac{Xc-XL}{R})$, Positive
55. a; $\omega = \frac{1}{\sqrt{LC}}$,maximum
56. b ; Resonance in ac circuits
57. b ;$\frac{\omega rL}{R}$,decreasing R
58. c ; Ohm
59. d; [$M^0L^0T^{2}$]
60. c : 180◦
61. (b) 4A
62. c : AC generator
63. (d). (1:1)
64. (d) : 0V (Sol: VL-VC= 50-50=0)
65. (c) : L/2 (Sol:$\omega r = \frac{1}{\sqrt{LC}}$)

OBJECTIVE TYPE QUESTIONS

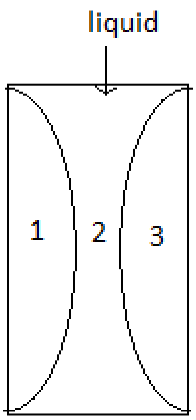
66. A: zero
67. Yes
68. Max: 1 ; Min:0
69. Root mean square value of current
70. zero (Phase difference between V and I is $\frac{\pi}{2}$. ∴$P_{av}= E_vI_v \cos\frac{\pi}{2}$ =0)
71. It depends upon L, C and R and the frequency of ac supply
72. When frequency is increased, the current in the circuit first increases, attains a maximum at resonant frequency and then decreases.
73. If power factor in a circuit is low, then the power consumption in the circuit is low
74. The magnetic flux is increased
75. It is due to production of eddy currents
76. Mutual Induction
77. Iron loss can be reduced by making use of laminated core
78. 100 (K=$\frac{Ns}{Np} = \frac{100}{1} = 100$)
79. 10 W (If there is no loss of energy, then the output power is equal to the input power.)
80. Because it is a material of low hysteresis
81. It is the loss of energy din the form of heat in core of a transformer
82. By using laminated iron core and by using suitable material for the core of a transformer
83. $e = NBA\omega \sin\omega t$
84. 10 (Sol: $\frac{Ip}{Is}$=$\frac{Es}{Ep}$=$\frac{2000}{200} = 10$)

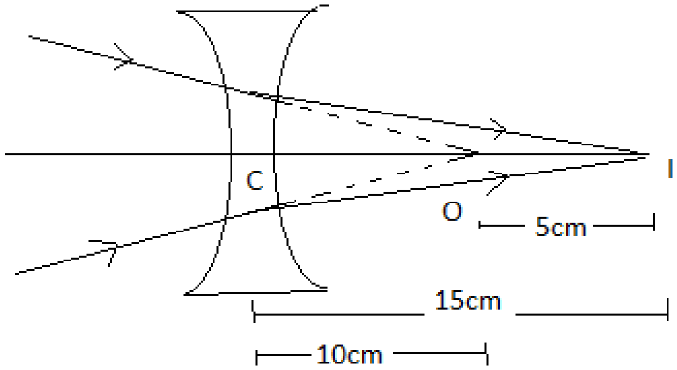
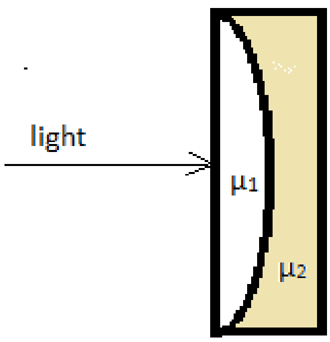
85. 25 (sol: $Q = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{1}{10}\sqrt{\frac{2}{32 X 10^{-6}}} = \frac{1000}{40}$ =25)

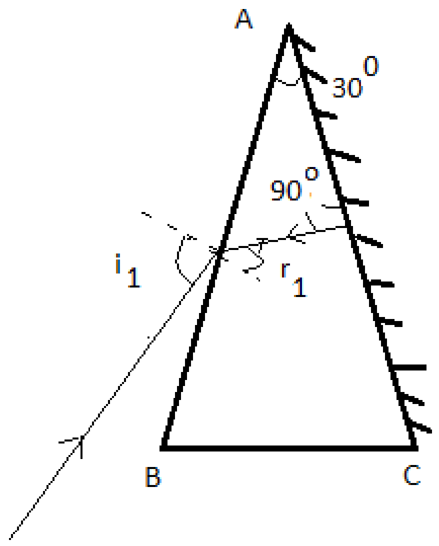
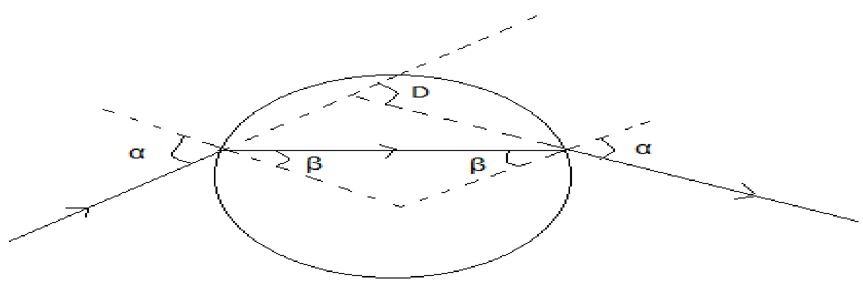
RAY OPTICS

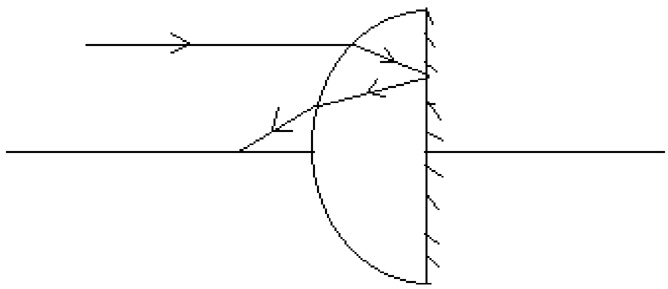
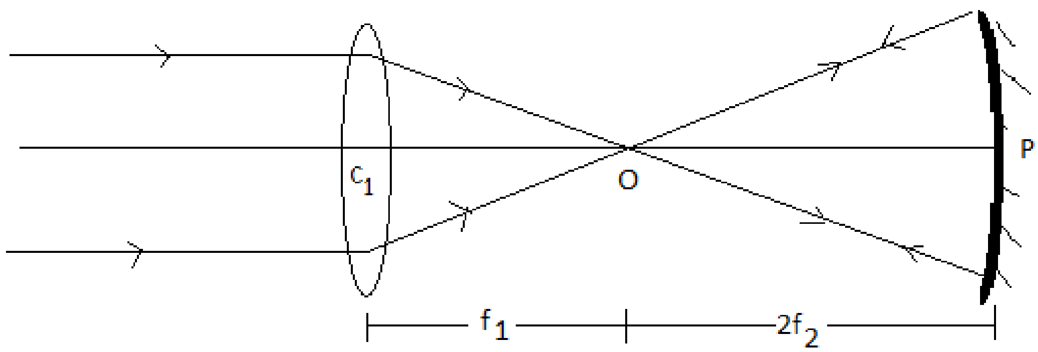
1	C
2	D
3	D
4	B
5	A
6	B
7	A
8	C
9	A
10	C
11	A
12	B
13	A
14	B
15	A
16	C
17	D
18	D
19	C
20	DIVERGING LENS
21	V I B G Y O R
22	SPED OF LIGHT IS MORE
23	TOTAL INTERNAL REFLECTION
24	180^0 - 2 i
25	n = C / V
26	SPHERICAL ABERRATION
27	N_{12} x N_{21} = 1
28	FREEQUENCY
29	AT CENTER OF CURVATURE
30	TWICE THE CRITICAL ANGLE
31.	i)
32.	ii)
33.	i)
34.	iv)

35.	iii)
36.	ii)
37.	i)
38.	iii)
39.	ii) Object at 2F of convex lens
40.	iii) Convex lens for eye piece and convex lens for objective
41.	iv) virtual & inverted
42.	iv) fo + fe
43.	iv) $\frac{1}{(m+1)}$ u=-mf, f=-f $\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$; $\frac{1}{v} = \frac{m+1}{u}$ Magnification M = $\frac{v}{u} = \frac{1}{m+1}$
44.	ii) 6 case 1: u=-25cm, f=20cm so using lens formula v=100 therefore m_{25}=- 4 case 2: u= -50cm, f= 20cm so using lens formula v=100/3 therefore m_{50}=-2/3 so, m_{25}/m_{50} = 6
45.	iii) f and 3I/4 By covering the aperture of diameter d/2, focal length is not affected. Area reduces by ¼, so does the intensity So new intensity = I-I/4 = 3I/4
46.	i) Increases $\mu_r<\mu_b$ $\frac{1}{f} = (\mu-1)(\frac{1}{R1} - \frac{1}{R2})$ So, $f_r>f_b$
47.	ii) Real, inverted, height = 4cm R_1=+20cm, R_2=-20cm $\frac{1}{f} = (\mu-1)(\frac{1}{R1} - \frac{1}{R2})$ F= 20cm U= -30cm, f = 20cm, using lens formula v = 60cm M = v/u =hi/ho Hi = -4cm
48.	i) Equal to that of sheet
49.	iv) $\frac{1}{f} = (\mu-1)(\frac{1}{R1} - \frac{1}{R2})$ For no dispersion f=0 So $R_1 = R_2$ =R
50.	ii) 1cm upward μ = Real depth/apparent depth = 3cm/apparent depth apparent depth = 2cm Distance through which mark appears to be raised = real depth- apparent depth =

	1cm
51.	iv) OA/2
52.	iv)
53.	ii) $\frac{1}{f} = (\mu-1)(\frac{1}{R1} - \frac{1}{R2})$ Putting R1=x , R2= -x and f=x we get μ=3/2
54.	iii) $\frac{1}{f} = \frac{1}{f1} + \frac{1}{f2}$, f_1= 20cm and f_2=-40cm we get f= 40cm so image at 40 cm.
55.	iii) δ = (μ-1)A on substitution we get μ = 3/2
56.	i) $\mu = \frac{\sin\{\frac{(A+D)}{2}\}}{\sin(\frac{A}{2})}$ A= 60^0, μ = √3, so, D=60^0
57.	iii) 20 cm
58.	 $\frac{1}{f} = (\mu-1)(\frac{1}{R1} - \frac{1}{R2})$ for lens 1 : R_1=infinity, R_2= -12cm, f_1= 24cm For lens 2 : R_1 = -12cm, R_2 = 12cm, $f_2 = \frac{-(\mu-1)}{6}$ For lens 3 : R_1= 12cm, R_2 = infinity $P=P_1+P_2+P_3$ μ = 1.6 iv) 1.6
59.	iii) -30cm

	 U = +10cm, , v= +15cm using lens formula f = -30cm
60.	ii) 40cm $\frac{1}{f} = (\mu-1)(\frac{1}{R1} - \frac{1}{R2})$ for first half lens : R_1=14cm, R_2= infinity, μ=1.5, f_1= 28cm for second half lens : R_1=infinity, R_2=-14cm, μ=1.2, f_2= 70cm $\frac{1}{f} = \frac{1}{f1} + \frac{1}{f2}$, we get f= 20cm Using lens formula v=40cm
61.	**iv)** $\frac{R}{(\mu1-\mu2)}$  $\frac{1}{f} = (\mu-1)(\frac{1}{R1} - \frac{1}{R2})$ For f_1 R_1= infinity, R_2= -R and for f_2 R_1= -R , R_2= infinity $\frac{1}{f} = \frac{1}{f1} + \frac{1}{f2}$ $f=\frac{R}{(\mu1-\mu2)}$
62.	iii)

	 $R_2 = 0^0$, $r_1 + r_2 = A$ so, $r_1 = 30^0$ $\mu = \frac{\sin(i1)}{\sin(r1)}$ $i_1 = 45^0$
63.	iv) 18cm, 2cm $M = \frac{Fo}{Fe} = 9$ For parallel rays adjustment i.e. normal adjustment Fo+Fe = 20cm So, Fe=2cm and Fo= 18cm
64.	ii) Lies between 2 and √2. $\mu = \frac{\sin\{\frac{(A+D)}{2}\}}{\sin(\frac{A}{2})}$ for D=A $\mu = \frac{\sin A}{\sin A/2}$ = 2 cos A/2 When $A=0^0$, $\mu_{max} = 2$ When $A= 90^0$, $\mu_{min} = \sqrt{2}$
65.	v) 20cm $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ If 1/v = y and 1/u = x Then y intercept is 1/f F= 1/0.05 = 20cm
66.	 D = (α-β) + (α-β) D = 2(α-β)

67.	i) $\frac{\mu 2}{\mu 1} = \frac{1}{\sin C}$ = 1.5/(4/3) So, sin C = 8/9
68.	iii)10cm When plane surface is silvered, light suffers refraction at convex surface, then reflection from plane surface and final refraction at the curved surface again as shown  Power of such a lens $P=P_1+P_2+P_3 = 2P_1$ (as $P_2=0$ and $P_1=P_3$) So, f= 10cm
69.	For 45^0 line u=-x, v=+x So, f=x/2 , x=2f So coordinates are (-2f,+2f)
70.	iii) $2f_1+f_2$ 

WAVE OPTICS

1. Option c
2. Option d
3. Option a
4. Option d
5. Option a

6. Option b

   Hint: use the formula

$$\frac{\text{Imax}}{\text{Imin}} = \left[\frac{\sqrt{I_1} + \sqrt{I_2}}{\sqrt{I_1} - \sqrt{I_2}}\right]^2$$

7. Option a

   Soln: $\frac{I_1}{I_2} = \frac{w_1}{w_2} = \frac{a^2}{b^2}$

   Given $w_2 = 2w_1$

   Substituting $b = a\sqrt{2}$

   $I_{max} \propto \left(a + a\sqrt{2}\right)^2 = 5.8a^2$

   $I_{min} \propto \left(a\sqrt{2} - a\right)^2 = 0.17a^2$

8. Option b

   Soln: use the formula $\frac{I_1}{I_2} = \frac{w_1}{w_2}$; $\frac{\text{Imax}}{\text{Imin}} = \left[\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}\right]^2$

9. Option b

   Soln: $\frac{12\lambda_1 D}{d} = \frac{n\lambda_2 D}{d}$

10. Option c

    Soln: $I_{max} = 4I$

    $I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$

    Substitute $I_1 = I_2 = I$ we get $\phi = \frac{2\pi}{3}$;

    $2\pi \longrightarrow \lambda$

    $\frac{2\pi}{3} \longrightarrow \frac{\lambda}{3}$

    $d\sin\theta = \frac{\lambda}{3}$

    $\theta = \sin^{-1}\left(\frac{\lambda}{3d}\right)$

11. Option d
12. Option c

13. Option b

    Soln: phase difference $\delta = \frac{\pi}{2} + \phi$

    $2\pi \longrightarrow \lambda$

    For a phase difference ϕ, path difference $\frac{\lambda}{2\pi}\phi$

    For a phase difference $\frac{\pi}{2} + \phi$, path difference $\frac{\lambda}{2\pi}\left(\phi + \frac{\pi}{2}\right)$

14. Option c
15. Option a
16. Option a
17. Option a

    Soln: use the formula $\frac{\beta}{\beta'} = \frac{\lambda}{\lambda'} = \mu$

18. Option a
19. option c

    soln: $\frac{\beta'}{\beta} = \frac{\lambda'}{\lambda}$

20. option b
21. option b

    Soln: width of 5th bright fringe-width of 3rd dark fringe

$$\frac{D\lambda n}{d} - \frac{D\lambda}{2d}(2n' - 1)$$

$$n = 5; n' = 3$$

22. option d
23. option b
24. option d
25. option c

    soln: $use the formula \frac{(A_1+A_2)^2}{(A_1-A_2)^2} = \frac{4I}{I}$

26. option c
27. option d
28. option a

29. option c
30. option a
31. option b
32. option b
33. option d

Soln: Let $I_1 = I_2 = I$

For path difference λ, phase difference is 2π

For path difference $\frac{\lambda}{3}$, phase difference is $\frac{2\pi}{3}$

Using the formula $I_{res} = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$

For the first case, $I_{res} = I + I + 2I\cos 2\pi = 4I = K(given)$

For the second case, $I'_{res} = I + I + 2I\cos\left(\frac{2\pi}{3}\right)$ = I = $\frac{K}{4}$

34. option d

Soln: use formula of position of dark fringe width and position of bright fringe

In liquid position of 5th dark fringe = $\frac{9\lambda D}{2d}$;--------(1)

In air, position of 8th bright fringe = $\frac{8\lambda' D}{d}$---------(2)

Equating 1 &2 (given) and solving we get $\lambda = \frac{16}{9}\lambda'$

$$\mu = \frac{\lambda}{\lambda'} = \frac{16}{9} = 1.78$$

35. option a

Soln: use the formula angular width = $\frac{\lambda}{d} = 0.1^0$ and convert ^{o} in to radians

$1^o = \frac{2\pi}{360} = 0.017 rad$

36. option d
37. option b
38. option a

Soln: infront of one of the slits given it means x = $\frac{d}{2}$

Path difference = $\frac{xd}{D} = \frac{\left(\frac{d}{2}\right)d}{10d} = \frac{d}{20} = \frac{5\lambda}{20} = \frac{\lambda}{4}$

For a path difference λ, phase difference = 2π

For a path difference $\frac{\lambda}{4}$, pahse difference = $\frac{2\pi}{4} = \frac{\pi}{2}$

I = $I_0 \cos^2 \frac{\phi}{2} = I_0 \cos^2 \frac{\pi}{4} = \frac{I_0}{2}$

39. option b

    Soln: use the formula

    intensity of bright fringes =$(A_1 + A_2)^2$

40. option b
41. Bending of light around the corners of obstacle or aperture is called diffraction of light.
42. Size of obstacle must be of the order of the wavelength of the wave.
43. dsinθ=λ, where d is width of slit.
44. Short waves are diffracted less and hence can be transmitted as a beam.
45. width of central maximum=2λD/d
46. Distance of the screen from the slit when the spreading of light due to diffraction is equal to the size of slit.
47. Spreading of light due to diffraction ∝ 1/wavelength
48. Interference is due to superposition of waves of two wave fronts emitted by two coherent sources. Diffraction is due to the superposition of waves from different portions of the same wave front.
49. The phenomena of restricting the vibration of light in a particular direction.
50. A light whose vibrations are restricted only in one plane.
51. Sound cannot be polarised.
52. 1.732
53. $I=I_0 \cos^2\theta$
54. A device which is used to produce the plane polarised light.
55. Polarisation of light.
56. It decreases.
57. Brewster angle depends upon wavelength (colour of light).
58. the angle for which the reflected light is completely plane polarised.
59. two Polaroid are known to be crossed Polaroid when the planes of polarisation are normal to each other.
60. Refractive index is numerically equal to the tangent of the angle of polarisation.
61. Light is transverse wave.
62. 45 degree
63. Wavelength
64. radio waves have longer wavelengths
65. Diffraction
66. Quinine iodosulphate

67. rotate the plane of polarization
68. sound waves
69. polarization
70. Decreases
71. because it cannot pass through vacuum
72. 50%
73. Remains the same
74. this is because objects around us are much bigger in size compared to the wavelength of visible light.
75. Decreases.
76. 60 degree
77. Plane of vibration, plane of polarisation and direction of propogation.
78. X-rays and radio waves.
79. Yes, it depends.
80. Coloured.

DUAL NATURE OF RADIATION AND MATTER

1.	C	2.	B	3.	A	4.	A	5.	A
6.	B	7.	B	8.	D	9.	A	10.	A
11.	B	12.	D	13.	C	14.	A	15.	D
16.	C	17.	D	18.	A	19.	A	20	A
21.	B	22.	B	23.	C	24.	B	25.	B
26.	C	27.	B	28.	A	29.	B	30.	C
31.	C	32.	B	33.	B	34.	A	35.	B

ATOMS

1. $r_o \, \alpha \frac{1}{E}$ So distance of closest approach reduces to $\frac{1}{3}$.
2. Transition" p" corresponds to maximum wavelength. Transition "s "corresponds to minimum wavelength.
3. Acc. To De Broglie:
   i. $\lambda = \frac{h}{mv}$ ➡ mv = $\frac{h}{\lambda} = \frac{h}{2\pi r}$ ➡ mvr = $\frac{h}{2\pi}$ [for n=1]
   ii. mvr = $\frac{nh}{2\pi}$ [Bohr's quantum condition]
4. a) Electron would lose its energy when moving around nucleus in circular orbit as it accelerates and spirals into nucleus- limitation of Rutherford.
   a. Acc. To Bohr, electron revolves in discrete stationary circular orbits without emission of radiant energy but emits only when transition takes place from one orbit to another.

5. Short wavelength limit of Lyman series is:

i. $\frac{1}{\lambda_L} = R\left[\frac{1}{1^2} - \frac{1}{\infty^2}\right] = R$

ii. Short wavelength limit for Balmer series is:

$\frac{1}{\lambda_B} = R\left[\frac{1}{2^2} - \frac{1}{\infty^2}\right] = \frac{R}{4}$ $\frac{\lambda_B}{\lambda_L} = \frac{4/R}{1/R} = 4$ →

b. Therefore, $\lambda_B = 4(913.4\dot{A}) = 3653\ \dot{A}$

6. Radius (r) $\alpha \frac{1}{m}$ and Energy (E) α m

a. Therefore, radius decreases by 400 times and energy increases by 400 times.

7. $E_n \alpha \frac{1}{n^2}$ for 3rd excited state, energy = $\frac{-13.6}{42}$ = -0.85 eV →

Energy required = [-0.85-(-13.6)] = 12.75 eV

8. Angular momentum L = mvr & Magnetic moment = $\frac{-e}{2m}$ L = $\frac{evr}{2}$

9. As r $\alpha \frac{n^2}{z}$ → doubly ionised Lithium has minimum radius.

10. The masses of the two nuclei are different.

11. The electrons would have been attracted by the nucleus due to Coulomb's attractive force . So atom would not have existed.

12. α particle should not suffer multiple scattering when it strikes the gold foil.

13. Impact parameter b=0: $b = \frac{Ze^2 cot\frac{\theta}{2}}{4\pi\epsilon o E}$

14. Ans. Ultraviolet region-Lyman series Visible region- Balmer series

15. First excited state n=2 Angular momentum =L= $\frac{nh}{2\pi} = \frac{h}{\pi}$

16. 1216$\dot{A}$

17. The radius of first orbit of hydrogen atom= 0.53$\dot{A}$

18. $En \propto Z^2 \therefore E_{he} = 2^2 \times (-13.6) = -54.4$eV

19. Negative energy of electron in the orbit signifies that electron and nucleus is a bound system.

20. Distance of closest approach estimates the size of nucleus.

21. $E_{He+}=Z^2(-13.6/n^2)=-13.6$eV [z=2,n=2]

22. v= $R[1/2^2-1/n_i^2]$ n_i=3,4,5.......

23. n=6(fifth exited state)

i. Number of spectral line emitted = N=n(n-1)/2=6x5/2=15

24. $r_n=n^2r_0=3^2$x5.3x10^{-11}m =4.77x10^{-10}m

25. TE=-3.4ev=-KE KE=3.4eV → PE=2xTE=-6.8eV

26. $E_{RP}= E_{RQ}+E_{QP}$ $h_c/\lambda_R= h_c/\lambda_P+ h_c/\lambda_Q$ $\lambda_R=\lambda_P\lambda_Q/\lambda_P+\lambda_Q$

27. For shortest wavelength n_1=2; $n_2= \infty$

a. $\frac{1}{\lambda}=R(1/2^2 - \frac{1}{\infty^2})=10^7 \times \frac{1}{4}$ $\lambda = 4/10^7 = 4\times10^{-7}$m=4000Å

28. (hc/λ)=E_2-E_1 => $hc/(E_2-E_1)=\lambda$ $\lambda = 4.87\times 10^{-7}$m

29. $\lambda_d/\lambda_\alpha = \sqrt{m_d x q_\alpha / m_\alpha x q_d} = 2$
30. $n_f=4$ to $n_i=1$

$n_2=4$ to $n_1=3,2,1......$ ③
$n_2=3$ to $n_1=2,1........$ ②
$n_2=2$ to $n_1=1$ ①

total= 6 transitions

31. This is because electrons interact only electromagnetically.
32. Alpha particles are heavier, move slowly, and possess large momentum. Hence they come in contact with large number of particles, so they possess high ionising power.
33. Since Bohr formula involves only product of the charges hence the formula remains unchanged.
34. According to Bohr model En directly proportional to $-13.6/n^2$ and angular momentum $mv^2 = n h / 2\pi$ when energy is different ''n'' is different. So angular momentum will also be different.
35. b= max for θ= 0 degrees represent atomic size
    a. b= min for θ=π represent nuclear size.
36. $\frac{1}{\lambda}$=R=wave number
    a. $\lambda = \frac{1}{R} = \frac{1}{1.097*10^7} = 9.11x10^{-8} = 911x10^{-10}m = 911$ Å
37. removal of electron from atom is easy as it requires few eV energy whereas for removal of nucleon 8MeV energy is required.
38. Whole of positive charge of atom is concentrated in a small central core called nucleus. Alpha particle being the positively charged is repelled by nucleus.
39. λ= h/mv i.e. λ α 1/v and v α 1/n λ α n hence De Broglie wave length increases
40. $d_\alpha = (Ze)(2e)/4\pi\dot{\epsilon}k_1$ $d_p = (Ze)(e)/4\pi\dot{\epsilon}k$
    $d_\alpha / d_p = (2e/k)/e/k_1$ $[2k_1/k]=1$ $k_1=k/2$
    Therefore kinetic energy of proton must be ½ in comparison with kinetic energy of α particle.
41. Ans: c) 1:4 (Energy E α Z^2 ,for n-1)
42. Ans: d) (Energy E α Z^2/n^2)
43. Ans: c) (λ= h/mv)
44. Ans: a) ultravioltet
45. a) (λ_m = 1240nm/V)
46. b) (P.E= -2 K.E)
47. b) 15 E_g/16 (n(n-1)/2 =6 n=4 so Emin= 15 E_g/16)
48. Ans: d) ¼ ($n=m^2/Z=5^2/100$)
49. Ans: d) energy levels are very close

50. b) $\sqrt{\lambda R}/(\lambda R - 1)$ [$1/\lambda = R\{1-(1/n^2)\}$]

51. d) $1/n^5$ ($B=\mu_0 ev/4\pi r^2$, $v \propto 1/n$, $r \propto n^2$)

52. d) Franck and Hertz experiment

53. b) 24 hR /25m [$1/\lambda = 24R/25$ $\lambda = h/mv$]

54. b) 3.33 Å [$\lambda = 2\pi r/n$, r=0.53 Å, n=1]

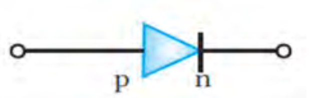
55. a) Increased

NUCLEI

1	D	11	D	21	A	31	B
2	B	12	B	22	D	32	B
3	E	13	B	23	A	33	A
4	B	14	D	24	B	34	A
5	A	15	A	25	A	35	A
6	A	16	C	26	D	36	A
7	A	17	B	27	A	37	C
8	E	18	C	28	D	38	B
9	D	19	B	29	B	39	C
10	C	20	B	30	A	40	B

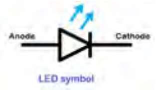
SEMICONDUCTOR ELECTRONIC DEVICES AND CIRCUITS

1. Decreases
2. Decreases
3. Voltage regulator
4. Half wave rectifier
5.



6.

7. ~ 0.2 V
8. from p side to n side.
9. Micro second
10. Two
11. Equal to the frequency of AC
12. From n side to p side
13. reverse biased
14. Third quadrant

15. Equal or slightly less than the band gap
16. Intensity of emitted light increases
17. Ga $As_{0.6}P_{0.4}$
18. E_g~ 1.4 ev
19. hν > E_g
20. (a) Fourth quadrant
21. mille Ampere
22. (b) D2 is forward biased and D_1 is reverse biased and hence no current flows from B and A and vice versa
    Explanation: As D_2 is grounded B is at higher potential hence it is forward biased and in D_1 ,A is at negative potential hence it is in reverse bias.
23. a, b, d
24. (a)
25. Reverse bias
26. (a)
27. (a)
28. Zener diode
29. Valence band.
30. Absorb photons
31. I_4
32. 5V
33. Minority carriers recombine with majority carriers near the junction.
34. (a)
35. (c)
36. Fractional change is measured easily in reverse bias
37. (d)
38.
    i. 

39. Longer terminal is p - type material and short terminal is n - type material
40. Gallium Nitride
41. Overlapped
42. Zener diode
43. Light emitting
44. Reverse
45. b
46. b
47. c
48. a

49. c
50. a.
51. more
52. Cu and GaAs
53. 5.05 ohm
54. 0.04 A
55. c.
56. 50%
57. 100%
58. very large
59. $5x10^9$/m3
60. Motion of charges under external field.
61. Motion of charges through the depletion region
62. c
63. below conduction band
64. knee voltage
65. Forward bias
66. electron concentration
67. $11.25x10^{-7}$ m
68. $12x10^{19}$
69. b
70. b
71. a
72. b
73. $5x10^6$ V
74. Reverse bias
75. c

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