Electric dipole moment	$\vec{p} = q(2a)\hat{n}$, $p = q(2a)$	Cm
Potential energy of a dipole in a unifor electric field	$U = -\vec{p}\cdot\vec{E}$, $U = -pE\cos\theta$, $U = -qE(2a\cos\theta)$	J
Electric field on axial line of an electric dipole	$E_{axial} = \frac{1}{4\pi\varepsilon_0}\frac{2p}{(r^2-a^2)^2}$, When $2a \ll r$, $E_{axial} = \frac{1}{4\pi\varepsilon_0}\frac{2p}{r^3}$	NC^{-1}
Electric field on equatorial line of an electric dipole	$E_{equatorial} = \frac{1}{4\pi\varepsilon_0}\frac{p}{(r^2+a^2)^{3/2}}$, When $2a \ll r$, $E_{equatorial} = \frac{1}{4\pi\varepsilon_0}\frac{p}{r^3}$	
Electric field as a gradient of potential	$E = -\frac{dV}{dr}$	
Electrical potential differences between points A & B	$V_B - V_A = \frac{W_{AB}}{q_0}$	Volts (or JC^{-1})
Electric potential at a point	$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r} = \frac{W_{A\infty}}{q}$	
Electric potential due to a system of charges	$V = \frac{1}{4\pi\varepsilon_0}\sum_{i=1}^{n}\frac{q_i}{r_i}$	
Electric potential at any point due to an electric dipole	$V = \frac{1}{4\pi\varepsilon_0}\frac{p\cos\theta}{(r^2-a^2\cos^2\theta)}$, When $\theta = 0°$ or $\theta = 180°$, $V = \frac{\pm p}{4\pi\varepsilon_0(r^2-a^2)}$	

CURRENT ELECTRICITY
IMPORTANT FORMULA

1.	Drift Velocity	$V_d = \frac{eE}{m}\tau$	E = electric field τ = Relaxation time
2.	Relation b/w current and Drift Velocity	$I = neAV_d$	e = charge on electrons m = mass of electron n = number density of electrons
3.	Ohm's Law	V = RI	A = cross Section Area
4.	Resistance	$R = \frac{\rho l}{A}$	V = potential difference across conductor
5.	Specific Resistance or Resistivity	$\rho = \frac{RA}{l} = \frac{m}{ne^2\tau}$	l = length of conductor
6.	Current density	$j = I/A = neV_d$	
7.	Electrical Conductivity	$\sigma = 1/\rho$	
8.	Resistances in Series	$R_{eq} = R_1 + R_2 + R_3$	

Ans. $V_0 = \frac{q\,k}{AO} + \frac{k\,q}{OC} - \frac{k\,q}{OB} - \frac{k\,q}{OD} = 0$

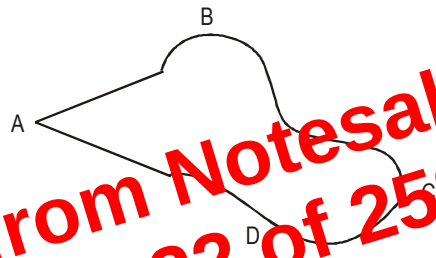
$$W = q \times V_{0^0} = 0$$

22. Calculate number of electric field lines orgnating from one coulomb charge.

Ans. Flux = Total electric field lines

$$\phi = \frac{q}{\epsilon_0} = \frac{l\,c}{\epsilon_0}$$

23. If the metallic conductor shown in the figure is continuously charged from which of the points A,B,C or D does the charge leak first. Justify.



Ans. Charge leaks from A first as surface charge density (σ) at A (sharp ends) is more.

24. What is dielectric strength? Write the value of dielectric strength of air.

Ans. $3x10^6\ Vm^{-1}$

25. Two charge –q and +q are located at points A (0, 0, –a) and B(0, 0, +a). How much work is done in moving a test charge from point (b, 0, 0) to Q (–b, 0, 0)?

Ans. $W = \vec{F} \cdot \vec{dr} = q\vec{E} \cdot \vec{dr} = q\ Edr\ \cos 90° = 0$

$\therefore$ E along equitorial line of diple is parallel to dipole, hence perpendicular to displacement.

26. If an electron is accelerated by a Potential difference of 1 Volt, Calculate the gain in energy in Joule and electron volt.

Ans. Gain in Energy = $eV = 1.6 \times 10^{-19} \times 1 = 1.6 \times 10^{-19} J$

16. What should be the charge on a sphere of radius 4 cm, so that when it is brought in contact with another sphere of radius 2cm carrying charge of 10 μC, there is no transfer of charge from one sphere to other?

Ans : Va = Vb, Q = 20μC

17. For an isolated parallel plate capacitor of capacitance C and potential difference V, what will happen to (i) charge on the plates (ii) potential difference across the plates (iii) field between the plates (iv) energy stored in the capacitor, when the distance between the plates is increased?

Ans : (i) No change (ii) increases (iii) No change (iv) increases.

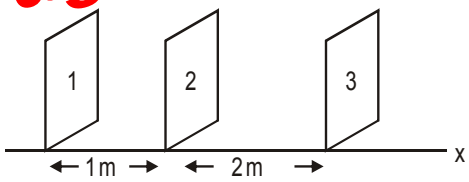
18. Does the maximum charge given to a metallic sphere of radius R depend on whether it is hollow or solid? Give reason for your answer. **Ans :** No charge resides on the surface of conductor.

19. Two charges Q_1 and Q_2 are separated by distance r. Under what conditions will the electric field be zero on the line joining them (i) between the charges (ii) outside the charge?

Ans : (i) Charge are alike (ii) Unlike charges of unequal magnitude.

20. Obtain an expression for the field due to electric dipole at any point on the equatorial line.

21. The electric field component in the figure are $\vec{E}_x = 2x\hat{i}$, $\vec{E}_y = E_z = 0$,. Calculate the flux through, (1,2,3) the square surfaces of side 5m.



22. Calculate the work required to separate two charges 4μc and –2μc placed at (–3cm, 0, 0) and (+3 cm, 0, 0) infinitely away from each other.

23. What is electric field between the plates with the separation of 2cm and (i) with air (ii) dielectric medium of dielectric constant K. Electric potential of each plate is marked in Fig.

_____150 V

(i) _____–50 V Ans. : $E_0 = 10^4 NC^{-1}$, $E = \frac{10^4}{k} NC^{-1}$

50. A meterbridge is in balance condition. Now if galvanometer and cell are interchanged, the galvanometer shows no deflection. Give reason.

[**Ans.** Galvanometer will show no deflection. Proportionality of the arms are retained as the galvanometer and cell are interchanged.]

51. If the emf of the driving cell be decreased. What will be effect on the position of zero deflection in a potentiometer.

52. Why should the area of cross section of the meter bridge wire be uniform? Explain.

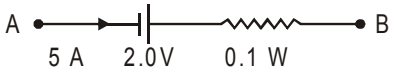
53. Given any two limitations of Ohm's law.

54. Which one of the two, an ammeter or a milliammeter has a higher resistance and why?

55. Name two factors on which the resistivity of a given material depends? A carbon resistor has a value of 62kΩ with a tolerance of 5%. Give the colour code for the resistor.

56. If the electron drift speed is so small (10^{-3} m/s) and the electron's charge is very small, how can we still obtain a large amount of current in a conductor

57. A battery of emf 2.0 volts and internal Resistance 0.1Ω is being charged with a current of 5.0A. What is the potential difference between the terminals of the battery?



58. Why should the jockey be not rubbed against potentiometer wire?

59. What is meant by the sensitivity of a potentiometer of any given length?

60. Five identical cells, each of emf E and internal resistance *r*, are connected in series to form (a) an open (b) closed circuit. If an ideal voltmeter is connected across three cells, what will be its reading?

[**Ans. :** (a) 3E; (b) zero]

61. An electron in a hydrogen atom is considered to be revolving around a proton with a velocity $\frac{e^2}{n}$ in a circular orbit of radius $\frac{n^2}{me^2}$. If I is the equivalent current, express it in terms of m, e, n $\left(n = \frac{h}{2\pi}\right)$. $\left(\frac{me^5}{2\pi n^3}\right)$

capacitor as shown in Fig. What will be the capacitance of the capacitor of initial area was A distance between plates d?

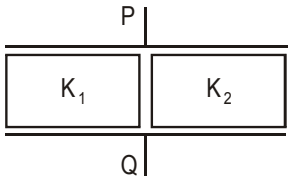


Fig. 1

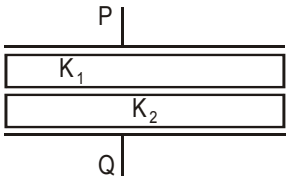
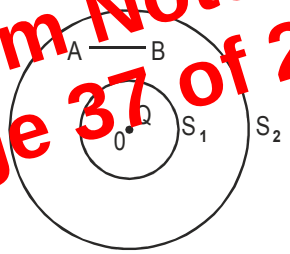


Fig. 2

$$C_1 = (K_1 + K_2)C_0$$

$$C_2 = \frac{K_1 K_2 C_0}{(K_1 + K_2)}$$

9. In the figure shown, calculate the total flux of the electrostatic field through the sphere S_1 and S_2. The wire AB shown of length l has a linear charge density λ given $\lambda = kx$ where x is the distance measured along the wire from end A.



Ans. Total charge on wire AB = $Q = \int_0^l \lambda\, dx = \int_0^l k\, x\, dn = \frac{1}{2}Kl^2$

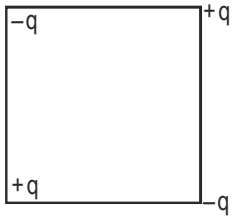
By Gauss's theorem.

$$\text{Total flux through } S_1 = \frac{Q}{\epsilon_0}$$

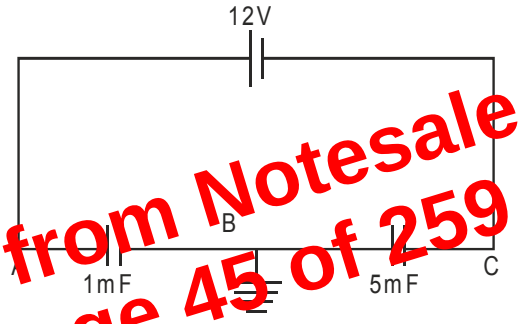
$$\text{Total flun through } S_2 = \frac{Q + \frac{1}{2}kl^2}{\epsilon_0}$$

10. Explain why charge given to a hollow conductor is transferred immediately to outer surface of the conductor. (*See* Page 83. NCERT Vol I)

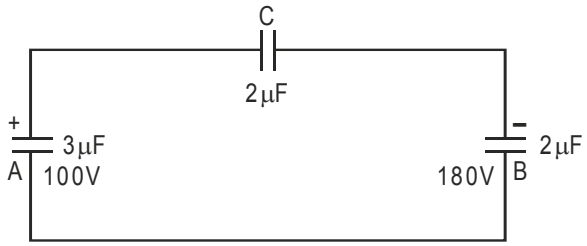
shown in the figure. Find the work done in disassembling the system of charges. $\left[\frac{kq^2}{a}\left(\sqrt{2}-4\right)\right]$ J



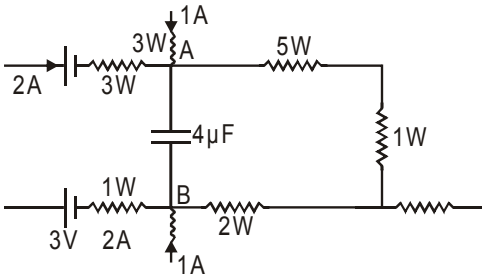
19. Find the potential at A and C in the following circuit :



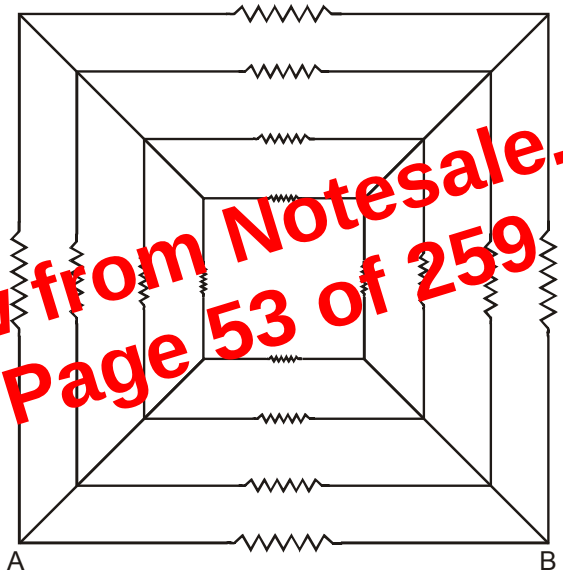
20. Two capacitors A and B with capacitances 3 μF and 2 μF are charged 100 V and 180 V respectively. The capacitors are connected as shown in the diagram with the uncharged capacitor C. Calculate the (i) final charge on the three capacitors (ii) amount of electrostatic energy stored in the system before and after the completion of the circuit.



21. Two identical parallel plate capacitors connected to a battery with the switch S closed. The switch is now opened and the free space between the plates of the capacitors is filled with dielectric of dielectric constant 3. Find the ratio of the total electrostatic energy stored in both capacitors before and after the introduction of dielectric.



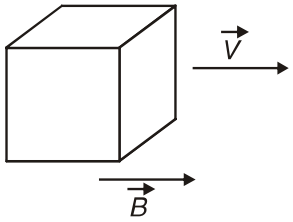
50. Sixteen resistors each of resistance 16Ω are connected in circuit as shown. Calculate the net resistance between A and B. [**Ans.** : 3Ω]



51. A voltmeter with resistance 500Ω is used to measure the emf of a cell of internal resistance 4Ω. What will be the percentage error in the reading of the voltmeter. [**Ans.:** 0.8%]

VALUE BASED QUESTIONS

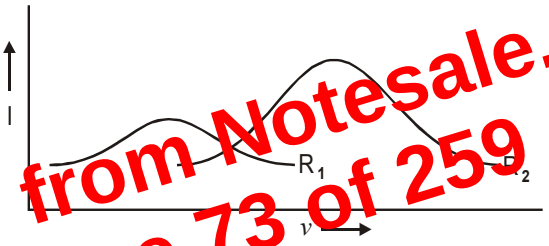
1. Geeta has dry hair. A comb ran through her dry hair attract small bits of paper. She observes that Neeta with oily hair combs her hair; the comb could not attract small bits of paper. She consults her teacher for this and gets the answer. She then goes to the junior classes and shows this phenomenon as Physics Experiment to them. All the junior feel very happy



Ans. Emf in each branch will be zero since V & B are parallel for all arms

$$\therefore \vec{F} = q\left(\vec{V} \times \vec{B}\right) = 0$$

34. Current versus frequency (I – ν) graphs for two different series L–C–R circuits have been shown in adjoining diagram. R_1 and R_2 are resistances of the two circuits. Which one is greater–R_1 or R_2?



Ans. $R_1 > R_2$ as I is smaller in larger resistance.

35. Why do we prefer carbon brushes than copper in an a.c. generator?

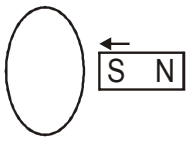
Ans. Corrosion free and small expansion on heating maintains proper contact.

*36. What are the values of capacitive and inductive reactance in a dc circuit?

Ans. $X_C = \infty$ for d c $\upsilon = 0$ $X_C = \dfrac{1}{w\,c} = \dfrac{1}{2\pi\upsilon c} = \infty$

$X_L = 0$ & $X_L = \omega L = 2\pi\upsilon L = 0$

37. Give the direction of the induced current in a coil mounted on an insulating stand when a bar magnet is quickly moved along the axis of the coil from one side to the other as shown in figure.

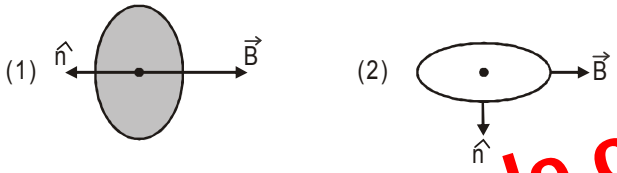


SHORT ANSWERS QUESTIONS (2 MARKS)

1. Write the four measures that can be taken to increase the sensitivity of a galvanometer.

2. A galvanometer of resistance 120Ω gives full scale deflection for a current of 5mA. How can it be converted into an ammeter of range 0 to 5A? Also determine the net resistance of the ammeter.

3. A current loop is placed in a uniform magnetic field in the following orientations (1) and (2). Calculate the magnetic moment in each case.



4. A current of 10A flows through a semicircular wire of radius 2cm as shown in figure (a). What is direction and magnitude of the magnetic field at the centre of semicircle? Would your answer change if the wire were bent as shown in figure (b)?

Fig. (a)

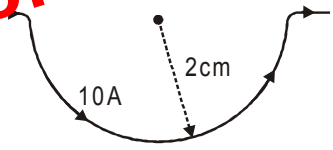


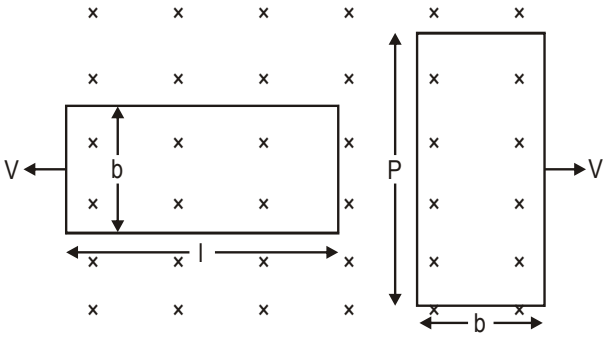
Fig. (b)

5. A proton and an alpha particle of the same enter, in turn, a region of uniform magnetic field acting perpendicular to their direction of motion. Deduce the ratio of the radii of the circular paths described by the proton and alpha particle.

6. Which one of the two an ammeter or milliammeter, has a higher resistance and why?

7. Mention two properties of soft iron due to which it is preferred for making electromagnet.

8. A magnetic dipole of magnetic moment M is kept in a magnetic field B. What is the minimum and maximum potential energy? Also give the most stable position and most unstable position of magnetic dipole.



27. A 1.5 μF capacitor is charged to 57V. The charging battery is then disconnected, and a 12 mH coil is connected in series with the capacitor so that LC Oscillations occur. What is the maximum current in the coil? Assume that the circuit has no resistance.

28. The self inductance of the motor of an electric fan is 10H. What should be the capacitance of the capacitor to which it should be connected in order to impart maximum power at 50Hz?

29. How does an inductor behave in a DC circuit after the current reaches to steady state? Justify.

30. How does an inductor behave in a AC circuit at very high frequency? Justify.

31. An electric bulb is commected in series with an inductor and an AC source. When switch is closed and after sometime an iron rod is inserted into the interior of inductor. How will the brightness of bulb be affected? Justify your answer.

Ans. Decreases, due to increase in inductive reactance.

32. Show that in the free oscillation of an LC circuit, the sum of energies stored in the capacitor and the inductor is constant with time.

Ans. Hint : $U=\frac{1}{2}LI^2+\frac{1}{2}\frac{q^2}{c}$

33. Show that the potential difference across the LC combination is zero at the resonating frequency in series LCR circuit

Ans. Hint P.d. across L is = IX_L

P.D. across C is $-IX_C$

$\Rightarrow \quad V = IX_L - IX_C$

at resonance $X_L = X_C$

$\Rightarrow \quad V = O.$

34. How does an capacitor behave in a DC circuit after the steady state? Explain your answer.

Ans. Capacitor acts as an open key.

35. For circuits used for transmitting electric power, a low power factor implies large power loss in transmission. Explain.

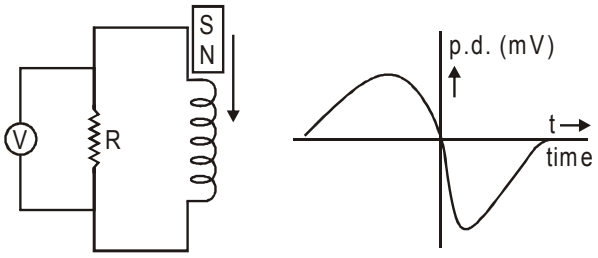
$\therefore \quad P = VI \cos \phi$

Or $\quad I = \dfrac{P}{V \cos \theta}$

if Cos θ is Low I will be high $\Rightarrow$ Large power loss

36. An applied voltage signal consists of a superposition of DC Voltage and an AC Voltage of high frequency. The circuit consists of an inductor and a capacitor in series. Show that the DC signal will appear across C where as AC signal will appear across L.

37. A bar magnet M is dropped so that is falls vertically through the coil C. The graph obtained for voltage produced across the coil Vs time is shown in figure.



(i) Explain the shape of the graph

(ii) Why is the negative peak longer than the positive peak?

6. Obtain an expression for the magnetic moment of an electron moving with a speed 'v' in a circular orbit of radius 'r'. How does this magnetic moment change when :

   (i) the frequency of revolution is doubled?

   (ii) the orbital radius is halved?

7. State Ampere, circuital law. Use this law to obtain an expression for the magnetic field due to a toroid.

*8. Obtain an expression for magnetic field due to a long solenoid at a point inside the solenoid and on the axis of solenoid.

9. Derive an expression for the torque on a magnetic dipole placed in a magnetic field and hence define magnetic moment.

10. Derive an expression for magnetic field intensity due to a bar magnet (magnetic dipole) at any point (i) Along its axis (ii) Perpendicular to the axis.

*11. Derive an expression for the torque acting on a loop of N turns of area A of each turn carrying current I, when held in a uniform magnetic field B.

*12. How can a moving coil galvanometer be converted into a voltmeter of a given range. Write the necessary mathematical steps to obtain the value of resistance required for this purpose.

13. A long wire is first bent into a circular coil of one turn and then into a circular coil of smaller radius having n turns. If the same current passes in both the cases, find the ratio of the magnetic fields produced at the centres in the two cases.

Ans. When there is only one turn, the magnetic field at the centre,

$$B = \frac{\mu_0 I}{2a}$$

$2\pi a^1 xn = 2\pi a \Rightarrow a^1 = a/n$

The magnetic field at its centre, $B_1 = \frac{\mu_0 nI}{2a/n} = \frac{\mu_0 n^2 I}{2a} = n^2 B$

The ratio is, $B_1/B = n^2$

14. Obtain an expression for the self inductance of a straight solenoid of length l and radius *r* (*l* >> *r*).

UNIT V & UNIT VI

ELECTROMAGNETIC WAVES AND OPTICS

KEY POINTS

- EM waves are produced by accelerated (only by the change in speed) charged particles.
- $\vec{E}$ and $\vec{B}$ vectors oscillate with the frequency of oscillating charged particles.
- Properties of em waves :
  - (i) Transverse nature
  - (ii) Can travel though vacuum.
  - (iii) $E_0 B_0 \in E/B = v$ $\quad v \rightarrow$ Speed of EM waves.
  - (iv) Speed = 3×10^8 m/s in vacuum.
  - (v) In any medium $v = \dfrac{1}{\sqrt{\mu \in}}$

    Where $\quad \mu = \mu_r \mu_0, \varepsilon = \varepsilon_r \varepsilon_0$

    $\sqrt{\epsilon_r} = n$ refractive index of medium

    Also $V = c/n$
  - (vi) Wave intensity equals average of Poynting vector $I = |\vec{S}|_{av} = \dfrac{B_0 E_0}{2\mu_0}$
  - (vii) Average electric and average magnetic energy densities are equal.

Combination of thin lenses	[redacted]
	$\Rightarrow$ P = $P_1 + P_2$ and $m = m_1 \times m_2$
Refraction in a prism	$\delta + A = i + e$
	[redacted]
Cauchy's formula (Relation *b/w* refractive index and λ)	[redacted]
Rayleigh's criteria of scattering	Amount of scattering [redacted]
Compound Microscope	
Magnification	[redacted]
When image is formed at D	[redacted]
When image is formed at infinity	[redacted]
The limit of resolution	[redacted]
Numerical aperture	$\mu \sin \theta$

28. Two independent light sources cannot act as coherent sources. Why?

29. How is a wave front different from a ray? Draw the geometrical shape of the wavefronts when.

    (i) light diverges from a point source,

    (ii) light emerges out of convex lens when a point source is placed at its focus.

30. What two main changes in diffraction pattern of single slit will you observe when the monochromatic source of light is replaced by a source of white light.

31. You are provided with four convex lenses of focal length 1cm, 3cm, 10cm and 100 cm. Which two would you prefer for a microscope and which two for a telescope.

32. Give reasons for the following

    (i) Sun looks reddish at sunset

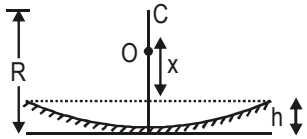
    (ii) clouds are generally white

33. Using Huygens Principle draw ray diagram for the following

    (i) Refraction of a plane wave front incident on a rarer medium

    (ii) Refraction of a plane wave front incident on a denser medium.

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



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

angle A. Deduce the relation

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

11. State the condition under which the phenomenon of diffraction of light takes place. Derive an expression for the width of the central maximum due to diffraction of light at a single slit. Also draw the intensity pattern with angular position.

NUMERICALS

1. The refractive index of medium is 1.5. A beam of light of wavelength 6000 A° enters in the medium from air. Find wavelength and frequency of light in the medium.
2. An *EM* wave is travelling in vaccum. Amplitude of the electric field vector is 5×10^4 V/m. Calculate amplitude of magnetic field vector.
3. Suppose the electric field amplitude of an em wave is $E_0 = 120\ NC^{-1}$ and that its frequency is $\nu = 50.0$ MHz.
   (a) Determine B_0, ω, k and λ. (b) Find expressions for E and B.
4. A radio can tune into any station of frequency band 7.5 MHz to 10 MHz. Find the corresponding wave length range.
5. The amplitude of the magnetic field vector of an electromagnetic wave travelling in vacuum is 2.4mT. Frequency of the wave is 16 MHz. Find :
   (i) Amplitude of electric field vector and
   (ii) Wavelength of the wave.
6. An *EM* wave travelling through a medium has electric field vector.

   $E_y = 4 \times 10^5 \cos (3.14 \times 10^8\ t - 1.57\ x)$ N/C. Here x is in m and t in s.

   Then find :

   (i) Wavelength (ii) Frequency
   (iii) Direction of propagation (iv) Speed of wave
   (v) Refractive index of medium (vi) Amplitude of magnetic field vector.

- de Broglie's hypothesis that electron have a wavelength $\lambda = h/mv$ gave an explanation for the Bohr's quantised orbits.

- Neutrons and protons are bound in nucleus by short range strong nuclear force. Nuclear force does not distinguish between nucleons.

- The nuclear mass 'M' is always less than the total mass of its constituents. The difference in mass of a nucleus and its constituents is called the **mass defect.**

$$\Delta M = [Zm_p + (A - Z)m_n] - M \text{ and } \Delta E_b = (\Delta M)c^2$$

The energy ΔE_b represents the binding energy of the nucleus.

For the mass number ranging from A = 30 to 170 the binding energy per nucleon is nearly constant at about 8MeV per nucleon.

- *Radioactive Decay Law :* The number of atoms of a radioactive sample disintegrating per second at any time is directly proportional to the number of atoms present at that time. Mathematically

$$\frac{dN}{dt} = -\lambda N \text{ or } N_{(t)} = N_0 e^{-\lambda t}$$

where λ is called decay constant. λ is defined as the reciprocal of the time during which the number of atoms of a radioactive substance decreases to 1with of the original number.

- Number of radioactive atoms N in a sample at any time *t* can be calculated using the formula.

$$N = N_0 \left(\frac{1}{2}\right)^{t/T}$$

Here No = no. of atoms at time $t = 0$ and T is the half-life of the substance.

Half life : The half life of a radio active substances is defined as the time during which the number of atoms disintegrate to one half of its initial value.

$$T_{1/2} = \frac{\ln 2}{\lambda} = \ln 2 \times \text{mean life}$$

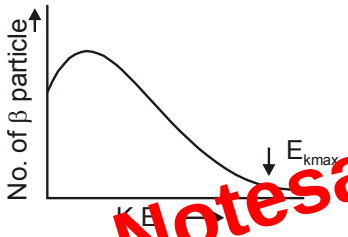
$$\text{or} \quad 0.693/\lambda = \frac{0.693}{\lambda}$$

1 Ci = 3.7×10^{10} Bq

46. The half life of a radioactive element A is same as the mean life time of another radioactive element B. Initially, both have same number of atoms. B decay faster than A. Why?

Ans. $T_A = \tau_B = 1.44\ T_B \ \ \therefore T_A > T_B \ \therefore \lambda_A < \lambda_B$. Therefore B decay faster than A.

47. Draw the graph showing the distribution of Kinetic energy of electrons emitted during β decay.



48. Compare radii of two nuclei of mass numbers 1 and 27 respectively.

Ans. $\frac{R_1}{R_2} = \left(\frac{1}{27}\right)^{1/3} = \frac{1}{3}$

$R_1 : R_2 = 1 : 3$

49. Which element has highest value of Binding Energy per nucleon.

Ans. $^{56}Fe_{26}$

50. Mention the range of mass number for which the Binding energy curve is almost horizontal.

Ans. For A = 30 to 120 (A is mass number)

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

Ans. 1 : 1 Because nuclear density is independent of mass numer.

$= 0.9315 \times 10^9$ eV

= 931.5 MeV

36. Write four properties of nuclear force.

SHORT ANSWER QUESTIONS (3 Marks)

1. Explain the working of a photocell? Give its two uses.

2. Find the de Broglie wavelength associated with an electron accelerated through a potential difference V.

3. What is Einstein's explanation of photo electric effect? Explain the laws of photo electric emission on the basis of quantum nature of light.

4. If kinetic energy of thermal neutron is $\frac{3}{2}kT$ then show that de-Broglie wavelength of waves associated with a thermal neutron of mass m at temperature T kelvin is $\frac{h}{\sqrt{3mkT}}$ where k is boltzmann constant.

5. Explain Davisson and Germer experiment to verify the wave nature of electrons.

6. Explain the effect of increase of (i) frequency (ii) intensity of the incident radiation on photo electrons emitted by a metal.

7. X-rays of wave length λ fall on a photo sensitive surface emitting electrons. Assuming that the work function of the surface can be neglected, prove that the de-Broglie wavelength of electrons emitted will be $\sqrt{\frac{h\lambda}{2mc}}$.

8. A particle of mass M at rest decays into two particles of masses m_1 and m_2 having velocities V_1 and V_2 respectively. Find the ratio of de-broglie Wavelengths of the two particles.

Ans. 1 : 1

9. Give one example of a nuclear reaction. Also define the Q-value of the reaction. What does Q > 0 signify?

10. Explain how radio-active nucleus can-emit β-particles even though nuclei

(b) Since P.E. = – 2E, PE = – 6.8 eV.

(c) If the zero of P.E. is chosen differently, K.E. does not change. The P.E. and T.E. of the state, however would alter if a different zero of the P.E. is chosen.

(i) When P.E. at ∞ is + 0.5 eV, P.E. of first excited state will be –3.4 – 0,5 = – 3.9 eV.

(iii) When P.E. at ∞ is + 0.5 eV, P.E. of first excited state will be –3.4 – (–0.5) = –2.9 eV.

20. What is beta decay? Write an equation to represent β^- and β^+ decay. Explain the energy distribution curve is β decay.

21. Using energy level diagram show emission of γ rays by $^{60}_{27}Co$ nucleus and subsequent β decay to obtain $^{60}_{28}Ni$. [CBSE] pg. 457

LONG ANSWER QUESTIONS (5 Marks)

1. State Bohr's postulates. Using these postulates, derive an expression for total energy of an electron in the n^{th} orbit of an atom. What does negative of this energy signify?

2. Define binding energy of a nucleus. Draw a curve between mass number and average binding energy per nucleon. On the basis of this curve, explain fusion and fission reactions.

3. State the law of radioactive disintegration. Hence define disintegration constant and half life period. Establish relation between them.

4. What is meant by nuclear fission and nuclear chain reaction? Outline the conditions necessary for nuclear chain reaction.

5. Briefly explain Rutherford's experiment for scattering of α particle with the help of a diagram. Write the conclusion made and draw the model suggested.

6. State law of radioactive decay obtain relation

(i) $N = N_0\, e^{-\lambda t}$

(ii) $R = R_0\, e^{-\lambda t}$

where N is number of radioactive nuclei at time t and

Note : The original ARPANET was shut down in 1990, and the NSF net was disconnected in 1995. These two are converted into the internet.

1.3 Who Govern the Internet

The internet is not run by any individual, so many organizations take responsibilities to govern the internet from which the main three organizations are.

1. **IAB (internet architecture board) :** This organization is acts as representative of the internet concerned with standards and other technical and organizational issues relevant to the world-wide Internet.
2. **IETF (internet Engineering Task Force) :** The mission of the IETF is to make the Internet work better by producing high quality, relevant technical documents that influence the way people design, use, and manage the Internet.
3. **Inter NIC (Internet Network Information Center) :** This is responsible for provide Public Information Regarding Internet Domain Name Registration Services.

1.4 WWW (Started in 1990)

It tends for world wide web. It is a set of programme & protocols that allow the users to create & display the combination of text, photographs, graphics, videos, audio & other multimedia files. Before www, internet was mainly used for obtaining textual information only, multimedia file can't be accessed.

Attributes of WWW

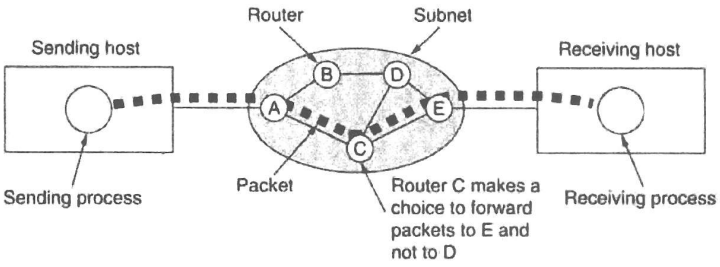
1. **Hypertext :** A hypertext is a text through which we can access or get other information of that text by clicking on it.
2. **Hypermedia :** A hypermedia is a file or any image or any other media through which we can access or get other information of that media by clicking on it.
3. **Hyperlink :** Hyperlink refer to the link through which we can open the other new web page by clicking on it.

1.5 Hyper Text Transfer Protocol

HTTP : It tends for Hypertext transfer protocol. It is an internet protocol that is used for fetching the information from server side. It fetch only textual informa-

2.3 Generation of Mobile Phone

Mobile phones have gone through three distinct generations, with different technologies:



1. Analog voice.
2. Digital voice.
3. Digital voice and data (Internet, e-mail, etc.).

2.3.1 First-Generation Mobile Phones : Analog Voice

This system used a single large transmitter on top of a tall building and had a single channel, used for both sending and receiving. To talk, the user had to push a button that enabled the transmitter and disabled the receiver. Such systems, known as push-to-talk systems, were installed in several cities beginning in the late 1950s. CB-radio, taxis, and police cars on television programs often use this technology.

In the 1960s, IMTS (Improved Mobile Telephone System) was installed. It, too, used a high-powered (200-watt) transmitter, on top of a hill, but now had two frequencies, one for sending and one for receiving, so the push-to-talk button was no longer needed. In this case the mobile users could not hear each other (unlike the push-to-talk system used in taxis).

IMTS supported 23 channels spread out from 150 MHz to 450 MHz. Due to the small number of channels, users often had to wait a long time before getting a dial tone. Also, due to the large power of the hilltop transmitter, adjacent systems had to be several hundred kilometers apart to avoid interference. All in all, the limited capacity made the system impractical.

Advanced Mobile Phone System

All that changed with AMPS (Advanced Mobile Phone System), invented in 1982.

- height (Z)
- time error (At)

It therefore follows that in three-dimensional space four satellites are needed to determine a position.

3.2 Determining a Position in 3-D Space

In order to determine these four unknown variables, four independent equations are needed. The four transit times required are supplied by the four different satellites (sat. 1 to sat. 4). The 28 GPS satellites are distributed around the globe in such a way that at least 4 of them are always “visible” from any point on Earth.

Despite receiver time errors, a position on a plane can be calculated to within approx. 5-10 m.

4. Write the truth table for a two input AND gate.

Ans.

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

5. At what temperature does a semiconductor behave as an insulator?

Ans. Fermi temperature

6. If L and C are the inductance and capacitance of the tank circuit of an oscillator, what will be the frequency of oscillation?

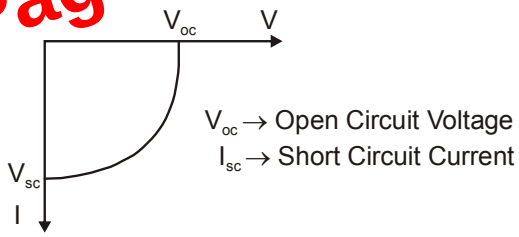
Ans. Frequency of AC $f = \frac{1}{2\pi\sqrt{LC}}$

7. Semiconductors do not support strong current, *i.e.*, a semiconductor is damaged when strong current passes through it. Why?

Ans. Because bonds break up, crystal breakdown takes place and crystal becomes useless.

8. Draw I–V characteristic of a solar cell.

Ans.



$V_{oc} \rightarrow$ Open Circuit Voltage
$I_{sc} \rightarrow$ Short Circuit Current

9. What is the phase difference between input and output waveform in the common emitter transistor amplifier?

Ans. Phase difference between input and output wave is π or 180°.

10. What is the direction of diffusion current in a junction diode?

Ans. The direction of diffusion current is from P to N in a semiconductor junction diode.

11. Draw a circuit diagram showing the biasing of a photodiode.

12. Name the semiconductor device that can be used to regulate an unregulated dc power supply.

Ans. Zener diode

13. Name the p.n. junction diode which emits spontaneous radiation when forward biased.

Ans. Light emitting diode (LED)

14. Name any one semiconductor used to make LED.

Ans. Ga As, Ga P

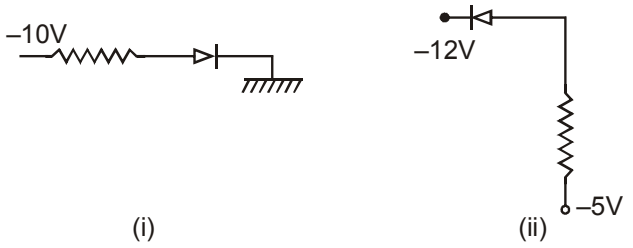
15. What is meant by 'regulation' as applied to a power supply?

Ans. Constant Power Supply

16. A semiconductor device is connected in a series circuit with a battery and a resistance. A current is found to pass through the circuit. When polarity of the battery is reversed, the current drops to almost zero. Name the semiconductor device.

Ans. P–N junction
(Junction Diode)

17. In the following diagram write which of the diode is forward biased and which is reverse biased?



(i) (ii)

Reverse biased Forward biased

18. How does the energy gap in a semiconductor vary, when doped, with a pentavalent impurity?

Ans. The energy gap decreases.

19. What is the order of energy gap in a conductor, semiconductor and insulator.

Ans. Conductor - no energy gap

Semiconductor <3eV

Insulator >3eV

20. The ratio of the 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* belong.

Ans. $\frac{n_e}{n_h} = 1 \Rightarrow n_e = n_h \quad \therefore$ Intrinsic semiconductor

$\frac{n_e}{n_h} < 1 \Rightarrow n_e < n_h \quad \therefore$ *p* type extrinsic semiconductor

21. What are ground waves?

Ans. The em. wave radiated from antenna which are transmitted through space along the ground. If a microwave from the transmitting antenna reaches to the receiving antenna either directly or after reflection from the ground, it is called a ground wave.

22. What are the two basic modes of communication?

Ans. (1) Analog (2) Digital

23. On what factors does the maximum coverage range of ground wave communication depend?

Ans. The maximum range of ground wave propagation depends upon.

(i) the frequency of transmitted wave

(ii) the power of the transmitter.

24. What is a base band signal?

25. What is the least size of an antenna required to radiate a signal of wavelength λ?

Ans. $\frac{\lambda}{4}$

26. Why do we use high frequencies for transmission?

Ans. To reduce the height of antena.

27. Why is ionisation low near the earth and high, far away from the earth?

Ans. The U.V. radiation and other high energy radiations coming from the outer space on entering ionosphere of Earth's atmosphere, are largely absored by the molecules of the layer of atmosphere. Due to this molecules get ionised. The degree of ionisation varies with height. At high attitude solar intensity is high, but density of Earth's atmosphere is low. Therefore, there are few air molecules to be ionised. On the other hand, close to the earth, the density of Earth's atmosphere is high but the radiation intensity is low. Due to of ionisation is low.

28. Define the modulation index.

Ans. Modulation index is defined as the ratio of the change in the amplitude of the carrier wave to the amplitude of the original carrier wave. It is also known as modulation factor.

29. What should be the length of dipole antenna for a carrier wave of frequency 2×10^6 Hz?

Ans. Length of dipole antenna : $\frac{\lambda}{2} = \frac{C}{2\upsilon}$

$$L = \frac{3 \times 10^8}{2 \times 2 \times 10^6} = 0.75 \times 10^2 \text{ m}$$

30. Why is the transmission of signals using ground wave communication restricted to a frequency of 1500 kHz?

Ans. The energy loss of a ground wave increases rapidly with the increase in frequency. Hence ground wave propagation is possible at low frequencies i.e. 500 KHz to 1500 KHz

31. What is meant by tranducer? Give one example of a transducer.

Ans. Any device which converts energy from one from to another is called transducer e.g. a microphone converts sound energy (signal) into an electrical energy (signal).

22. To make transistor to act as an amplifier.

24. N.C.E.R.T. pg. 477

25. N.C.E.R.T. pg. 477

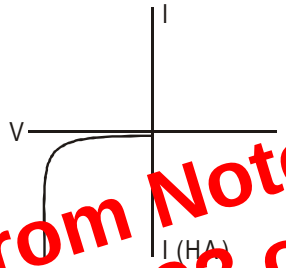
26. Ge ~ 0.2V

Si ~ 0.7 V.

27. Output circuit is reverse biased, which has large resistance.

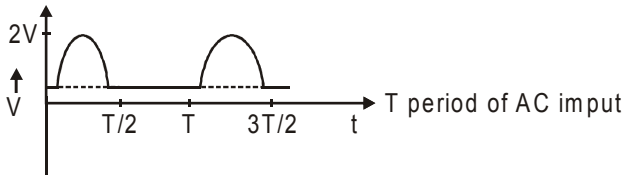
28. (i) Reverse bias

(ii)



29. (b)

30. Output waveform is :



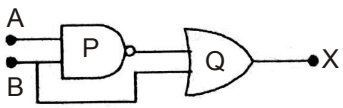
NUMERICALS

1. (i) $V = Ed = 7 \times 10^5 \times 300 \times 10^{-9} = 0.21V$

(ii) Kinetic energy = eV = 0.21 eV

2. Emitter current $I_e = \frac{10}{90} \times 100 = 11.11$ mA

12. Identify the logic gates marked 'P' and 'Q' in the given circuit. Write the truth table for the combination.



Ans. P in NAND Gate

Q is OR Gate **[1/2+1/2+1]**

Truth Table :

A	B	$\overline{AB}$	$B+\overline{AB}$
0	0	1	1
0	1	1	1
1	0	1	1
1	1	0	1

13. State Kirchhoff s rules. Explain briefly how these rules are justified.

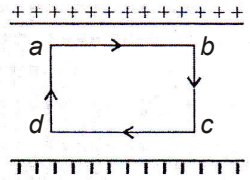
Ans. ***Kirehoff's Current (Junction) Rule :*** At any junction, the sum of the currents entering the junction is equal to the sum of current leaving the junction.

When currents are steady, there is no accumulation of charge at any junction or at any point in a line. This is based on the conservation of charge.

Kirchoff loop rule: The algebric sum of changes in potential difference across all the elements in any closed loop involving resistors and cells is zero.

This law is based on the conservation of energy. [1]

14. A capacitor 'C' a variable resistor 'R' and a bulb 'B' are connected in series to the ac main; in circuit as shown. The bulb glows with some brightness. How will the glow of the bulb change if (i) a dielectric slab is introduced between the plates of the capacitor, keeping resistance R to be the same; (ii) the resistance R is increased keeping the same capacitance ?



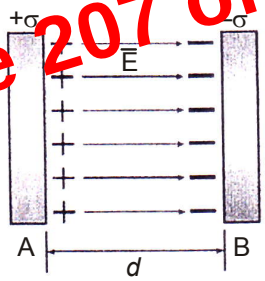
Ans. (a) Assume the capacitor is being charged and, at some moment, has a charge q on it.

The small work needed to transfer a charge dq from one plate to the other:

$$dW = Vdq = \frac{q}{C}dq$$

The **total work** required: $W = \int_0^Q \frac{q}{C}dq = \frac{Q^2}{2C}$ [2+1]

The energy can be considered to be stored in the **electric field** between the plates.



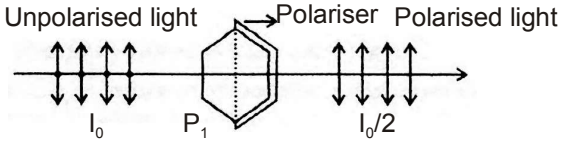
Energy Density

Suppose we have a parallel plate capacitor, as in figure, the field strength between the plates and total charge are given in terms of charge density a and plate are A by

$$E = \frac{\sigma}{\varepsilon_0}$$

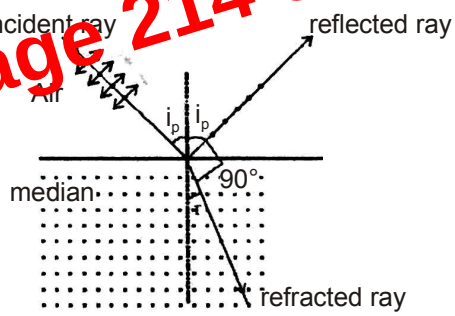
$$Q = A\sigma$$

Ans.(a)



Polariser has a pass axis along which if any electric field vector lies, it will get transmitted to the other side. If an electric field vector which is perpendicular the pass axis, falls on the polariser then, it gets absorbed. We know that an unpolarised light has two components of electric field vector, one of which is parallel to the pass axis and the other which is perpendicular to the pass axis. Since, the perpendicular component gets absorbed, the output light obtained is a polarised light whose electric field vector is parallel to the pass axis.

(b) When unpolarised light is incident on the interface of two transparent media the reflected light is polarised. If the unpolarised light is incident at the angles 0° or 90°, the reflected ray remains unpolarised. When the reflected wave is perpendicular to the refracted wave the reflected wave is totally polarised. The angle of incidence in this case is called polarising angle or Brewster's angle (i_p).



Brewster's Law says that when an unpolarised light is incident on a transparent surface of refractive index *(n)* at the polarising angle (i_p) such that the reflected ray and the refracted ray are perpendicular to each other, the reflected light is totally plane polarised and in that condition $n = \tan i_p$. From the diagram,

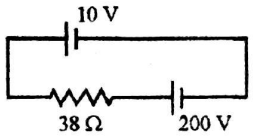
$$i_p + 90° + r = 180°$$

$$I_p + r = 90° \text{ or } r = 90 - i_p$$

Q5. Name the protocol used by internet to search the information over the network?

Q.6 (i) A capacitor has been charged by a dc source. What are the magnitude of conduction and displacement current, when it is fully charged?

(ii) A 10 V battery of negligible internal resistance is connected across a 200 V battery and a resistance of 38Ω as shown in the figure. Find the value of the current in circuit.



Ans. When capacitor is fully cbamect dwm current through it is zero. Since magnitude of conduction current is same as magnitude of displacement current so both are zero.

Since, the positive terminal of the batteries are connected together, so the equivalent emf of the batteries is given by $\varepsilon = 200 - 100 = 190V$.

Hence, the current in the circuit is given by

$$I = \frac{\varepsilon}{R} = \frac{190}{38} = 5Amp.$$

Q7. State Lenz's Law.

A metallic rod held horizontally along east-west direction, is allowed to fall under gravity. Will there be an emf induced at its ends? Justify your answer.

Ans. Lenz's law states that the polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produces it.

Yes, emf will be induced in the rod as there is change in magnetic flux. As metallic rod held horizontally along eastwest direction, is allowed to fall freely under gravity then it intersect the horizontal component of earth's magnetic field which is along south-north direction. Hence emf is induced in it.

(If it is dropped exactly at pole there will be no induced emf because there is no horizontal component of magnetic field).

Q8.(a) Write the necessary conditions for the phenomenon of total internal reflection to occur.

(b) Write the relation between the refractive index and critical angle for a given pair of optical media.

Ans.(a) Necessary conditions for total internal reflection to occur are :

(i) The incident ray on the interface should travel trrnn optically denser medium to rare medium.

(ii) The angle of incidence should be greater than the critical angle for the given pair of optical media.

(b) ${}^{*}\mu_b = \frac{1}{\sin C}$. a and b are the rarer and denser media respectively. C is the critical angle for the given pair of optical media.

Q9. Using Bohr's postulates, obtain the expression for the total energy of the electron in the stationary states of the hydrogen atom.

Ans. According to Bohr's postulates, in a hydrogen atom, a single alectron revolves around a nucleus of charge +e. For an electron moving with a uniform speed in a circular orbit of a given radius, centrip etal force is provided by Columbo rce of attraction between the electron and the nucleus. The gravitational attraction may be neglected as the mass of electron and proton is very small.

So,

$$\frac{mv^3}{r} = \frac{ko^2}{r^2}$$

or $$mv^2 = \frac{kv^2}{r} \qquad ...(1)$$

where m = mass of electron

r = radius of electronic orbit

v = velocity of electron.

Again $$mvr = \frac{nh}{2\pi}$$

or $$v = \frac{nh}{2\pi mr}$$

From eq.(1), we get,

$$m\left(\frac{nh}{2\pi mr}\right) = \frac{ke^2}{r}$$

$$\Rightarrow \quad r = \frac{n^2h^2}{4\pi^2kme^3} \qquad (2)$$

(i) Kinetic energy of electron

$$E_r = \frac{1}{2}mv^2 = \frac{ke^2}{2r}$$

Using eq (2), we get

$$E_K = \frac{ke^3}{2}\frac{4\pi^2kme^2}{n^2h^2}$$

$$= \frac{2\pi^2k^2me^4}{n^2h^2}$$

$$E_K = \frac{k}{2}\frac{4\pi^2kme^2}{n^2h^2}$$

$$t = 0 \text{ and } t = \frac{\pi}{\omega}$$

(ii) Potential Energy

$$E_P = -\frac{k(e)\times(e)}{r} = -\frac{ke^2}{r}$$

Q10. Explain, with the help of a circuit diagram, the working of a photo-diode. Write briefly how it is used to detect the optical signals.

OR

Mention the important considerations required while fabricating a p-n junction diode to be used as a Light Emitting Diode (LED). What should be the order of band gap of on LED if it is required to emit light in the visible range?

Calculate :

(i) The potential V and the unknown capacitance C

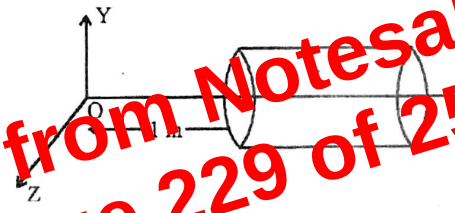
(ii) What will be the charge stored in the capacitor, if the voltage applied had increased by 120 V?

OR

A hollow cylindrical box of length 1 m and area of cross-section 25 cmz is placed in a three dimentional coordinate system as shown in the figure. The electric field in the region is given $\vec{E} = 50x\hat{i}$, where E is NC-1 and x is in metres. Find

(i) Net flux through the cylinder.

(ii) Charge enclosed by the cylinder.



Ans. (i) Initial voltage, V = V volts and charge stored, Q, = 360 μC.

$Q_1 = CV_1$ ..(1)

Changed potential, V_2 = V – 120

Q_2 = 120 μC

$Q_2 = CV_2$ ..(2)

By dividing (1) by (2), we get

$$\frac{Q_1}{Q_2} = \frac{CV_1}{CV_2} \Rightarrow \frac{360}{120} = \frac{V}{V-120} \Rightarrow V = 180 \text{ volts}$$

$$C = \frac{Q_1}{V_1} = \frac{360 \times 10^{-3}}{180} = 2 \times 10^{-2} F = 2\mu F$$

(ii) If the voltage applied had increased by 120 V, then V_3 =180 + 120 = 300 V. Hence, charge stored in the capacitor,

Ans. We have, resistance of ammeter, RA = 0.80 ohm and nuuciunmicurrent across ammeter,

$$I_A = 1.0A$$

So, voltage across ammeter,

$$V = IR = 1.0 \times 0.80 = 0.8V.$$

Let the value be x.

(i) Resistance of ammeter with shunt,

$$R = \frac{R_A x}{R_A + X} = \frac{0.8x}{0.8 + X}$$

Current through ammeter, I = 5 A.

$$\therefore \quad \left(\frac{0.8x}{0.8 + x}\right) \times 5 = 0.8$$

$$\Rightarrow \quad 0.8(0.8 + x) = 4x$$

$$\therefore \quad x = \frac{0.64}{3.2} = 0.2$$

Thus, the shunt resistance is 0.2 ohm

(iii) Combined resistance of the ammeter and the shunt,

$$R = \frac{0.8x}{0.8 + x} - \frac{0.8 \times 0.2}{0.8 + 0.2} - \frac{0.16}{1} = 0.16 \text{ ohm}$$

Ans. Permanent mangets are those magnets which have high retentivity and coercivity. For example : Steel, earth, Uarnaagnet etc.

Q15.(a) In what way is diffraction from each slit related to the interference pattern in a double slit experiment.

(b) Two wavelengths of sodium light 590 nm and 596 nm are used, in turn to study the diffraction taking place at a single slit of aperture 2 x 101 m. The distance between the slit and the screen is 1.5 m. Calculate the separation between the positions of the first maxima of the diffraction pattern obtained in the two cases P.

Ans.(a) If the width of each slit is con-yarable to the wavelength of light used the interference pattern thus obtained ui the double-slit experiment is modified by diffraction pattern due to each slit.

(b) Given that: Wavelength of the light beam, λ_1 = 590nm = 5.9 × 10^{-7} m

Wavelength of another light beam, $\lambda_2 = 596nm = 5.96 \times 10^{-7} m$

Distance of the slits from the screen

= D = 1.5 m

aperture = a = 2 x 10^{-4} m

For the first secondary maxima,

$$\sin\theta = \frac{3\lambda_2}{2a} = \frac{x_1}{D}$$

or $x_1 = \frac{3\lambda_1 D}{2a}$ *and* $x_2 = \frac{3\lambda_2 D}{2a}$

∴ Spacing between the positions of first secondary maxima of two ocliuni lines

$$x_2 - x_1 = \frac{3D}{2a}(\lambda_2 - \lambda_1)$$

= 6.75 x 10^{-5} m

Q16.(i) Write the relationship between angle of incidence 'i', angle or prism 'A' and angle of minimum deviations for a triangular prism.

(ii) An em wave is travelling in a medium with a velocity $\hat{v} = v\hat{i}$. Draw a sketch showing the propagation of the em wave, indicating the direction of the oscillating electric and magnetic fields.

(iii) How are the magnitudes of the electric and magnetic fields related to velocity of the em wave?

Ans. The relation between the angle of incidence I, angle of prism, A and the angle of minimum deviation, Δ_m for a triangular prism is given as is given by $i - \frac{A + \Delta_m}{2}$.

$$= \frac{400 - 500}{100} = \frac{-100}{100} = -1D$$

As the power is negative, the system will be diverging in nature.

Air bubble behave as concave lens.

Q18.(a) In a typical nuclear reaction e.g.

$$^2_1H + ^2_1H \rightarrow ^3_2He + n + 3.27MeV$$

although number of nucleons is conserved, yet energy is released. How? Explain.

(b) Show that nuclear density in a given nucleus is independent of mass number A.

Ans.(a) In a nuclear reaction, the sum of the largest nucleus $\left(^2_1H\right)$ and the bombarding particle $\left(^2_1H\right)$ may be greater or less than the sum of masses of the product nucleus $\left(^3_1He\right)$ and the outgoing particle $\left(^1_0n\right)$. So from the law of conservation of mass energy, some energy (3.27 MeV) is evolved or involved in a nuclear reaction. This energy is called Q-Value of the nuclear reaction.

(b) Density of the nucleus $= \frac{\text{mass of nucleus}}{\text{volume of nucleus}}$

mass of nucleus = A amu = A × 1.66 × 10^{-27} kg

volume of nucleus

$$= \frac{4}{3}nR^3 = \frac{4}{3}\pi\left(R_0A^{1/3}\right) = \frac{4}{3}\pi R_0^3A.$$

Thus, density

$$= \frac{A \times 1.66 \times 10^{-2}}{\left(\frac{4}{3}\pi R_0^3\right)A} = \frac{1.66 \times 10^{-27}}{\left(\frac{4}{3}\pi R_0^3\right)}$$

which show the density is independent of mass number A.

Using $R_0 = 1.1 \times 10^{-15} m$ and

density $= 2.97 \times 10^{17} \text{kg m}^{-3}$

Q19.(a) Why photoelectric effect cannot be explained on the basis of wave nature of light? Give reasons.

(b) Write the basic features of photon picture of electromagnetic radiation on which Einstein's photoelectric equation is based.

Ans.(a) Wave nature of radiation cannot explain the following:

(i) The instantaneous ejection of photoelectrons.

(ii) The existence of threshold frequency for a metal surface.

(iii) The fact that kinetic energy of the emitted electrons is independent of the intensity of light and depends upon its frequency. Thus, the photoelectric effect cannot be explained on the basis of wave nature of light.

(b) Photon picture of electromagnetic radiation on which Einstein's photoelectric equation is based on particle nature of light. Its basic features is:

In photon-particle collision (such as photon-electron collision), the total energy and total momentum are conserved. However, number of photons may not be conserved.

Q20. Write three important factors which justify the need of modulating a message signal. Show diagrammatically how an amplitude modulated wave is obtained when a modulating signal is superimposed on a carrier wave.

Ans. Three important factors which justify the need of modulating a message signal:

(i) **Size of antenna or aerial:** For communication within the effective but small length of the antennas, the transmitting frequencies should be high, so modulation is required.

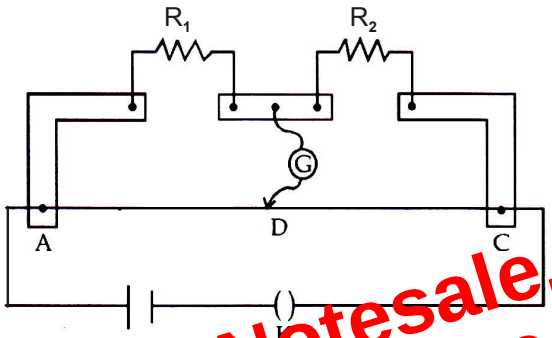
(ii) **Effective power which is radiated by antenna:** Since the power radiated from a linear antenna is inversely proportional to the square of the transmitting wavelength. As high powers are needed for good transmission so, higher frequency is required which can be achieved by modulation.

(iii) The interference of signals from different transmitters: To avoid the

OR

(a) State Kirchhoff's rules for an electric network. Using Kirchhoff's rules, obtain the balance condition in terms of the resistances of four arms of Wheatstone bridge.

(b) In the meterbridge experimental set up, shown in the figure, the null point 'D' is obtained at a distance of 40 cm from end A of meterbridge wire.



If a resistance of 10Ω is connected in series with R_1, null point is, obtained at AD = 60 cm. Calculate the value of R_1 and R_2.

Ans: (a) Refer theory

(b) (i) The emf of the cell connected in main circuit may not be more than the emf of the primary cells whose emfs are to be compared.

(ii) The positive ends of all cells are not connected to the same end of the wire.

OR

(a) Refer NCERT

(b) Considering both the situations and writing them in the form of equations Let R' be the resistance per unit length of the potential meter wire,

$$\frac{R_1}{R_2} = \frac{R' \times 40}{R'(100-40)} = \frac{40}{60} = \frac{2}{3}$$

$$\frac{R_1 + 10}{R_2} = \frac{R' \times 60}{R'(100-60)} = \frac{60}{40} = \frac{3}{2}$$

Ans.(a) Refer NCERT

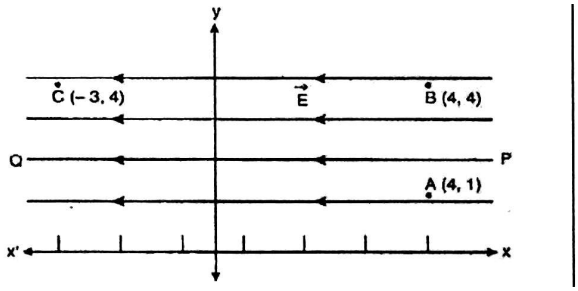
(b) Refer NCERT

OR

(a) Refer NCERT

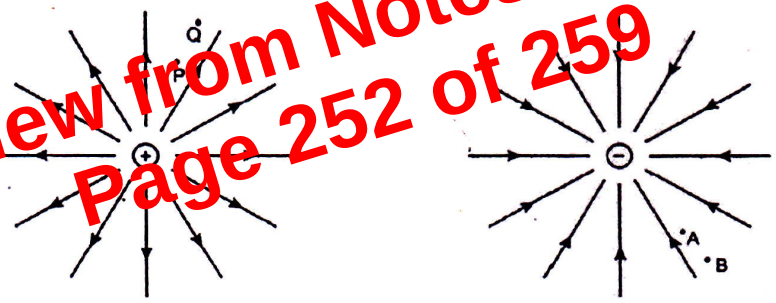
(b)(i) The frequency of reflected and refracted light remains same as that of the frequency of incident light because frequency only depends on the source of light.

(ii) Since the frequency remains same, hence there is no reduction in energy.



OR

An electric dipole of dipole moment p is placed in a uniform electric field E. Write the expression for the torque 'T' experienced by the dipole. Identify two pairs of perpendicular vectors in the expression. Show diagramatically the orientation of the dipole in the field for which the torque is (i) maximum, (ii) half the maximum value, (iii) zero. Fig (a) and (b) show the field lines of a single positive and negative charges respectively.



(a) Give the sign of the potential difference : $V_P - V_Q$ and $V_B - V_A$

(b) Give the sign of the potential energy difference of a small negative charge between the points Q and P; A and B.

(c) Give the sign of the work done by the field in moving a small positive charge from Q to P.

(d) Give the sign of the work done by an external agency in moving a small negative charge from B to A.

Q26.(i) A thin lens, having two surfaces of radii of curvature r_1 and r_2, made from a material of refractive index μ_2, is kept in a medium of refractive index μ_1. Derive the Lens Maker's formula for this 'set-up'