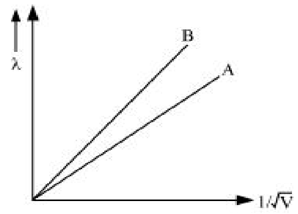
Section A (Very Short Answer Type Questions)

1. Name the physical quantity whose S.I. unit is J/C. Is it a scalar or a vector quantity?
2. 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.
3. State Lenz's law in electromagnetic induction.
4. What is the ratio of velocities of light rays of wavelengths 4000 Å and 8000 Å in vacuum?
5. Out of speed, frequency and wavelength which physical quantity remains unchanged with the refraction of wave?
6. Two nuclei have mass numbers in the ratio 1:8.What is the ratio of their nuclear radii?
7. Among alpha, beta and gamma radiations, which does not get affected by electric field?
8. Two nuclei have mass numbers in the ratio 1: 2. What is the ratio of their nuclear densities?

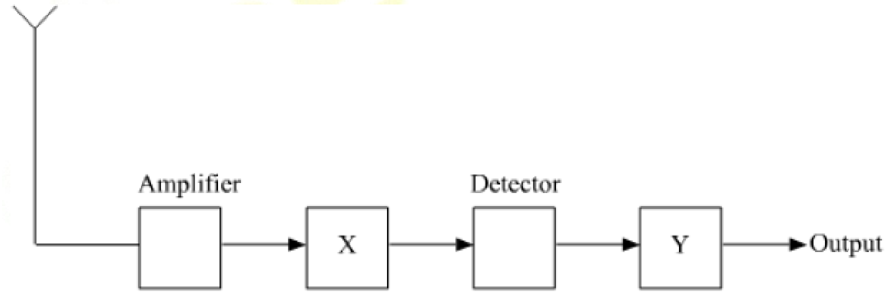
Section B (Short Answer Type Questions Type 1)

9. An electric dipole is held in a uniform electric field.
   (i) Show that the net force acting on it is zero.
   (ii) The dipole is aligned parallel to the field. Find the work done in rotating it through the angle of 180°.
10. A circular coil of N turns and radius R carries a current I. It is unwound and rewound to make another coil of radius R/2, current I remaining the same. Calculate the ratio of the magnetic moments of the new coil and original coil.
11. (i) Write two characteristics of a material used for making permanent magnets.
    (ii) Why is the core of an electromagnet made of ferromagnetic materials?
12. Draw magnetic field line when a (i) diamagnetic, (ii) paramagnetic substance is placed in an external magnetic field. Which magnetic property distinguishes this behaviour of the field line due to the substances?
13. Draw a plot of potential energy of a pair of nucleons as a function of their separations. Mark the regions where the nuclear force is (i) attractive and (ii) repulsive. Write any two characteristic features of nuclear forces.
14. State the law of radioactive decay. Establish a mathematical relation between half-life period and disintegration constant of a radioactive nucleus.
15. Find the radius of curvature of the convex surface of a plano-convex lens, whose focal length is 0.3 m and the refractive index of the material of the lens is 1.5.
16. A charge 'q' is placed at the centre of a cube of side l. Using Gauss law find electric flux passing through each face of the cube?
17. Two lines, *A* and *B*, in the plot given below show the variation of de Broglie wavelength, λ versus $\frac{1}{\sqrt{V}}$, where *V* is the accelerating potential difference, for two particles carrying the same charge. Which one of two represents a particle of smaller mass?

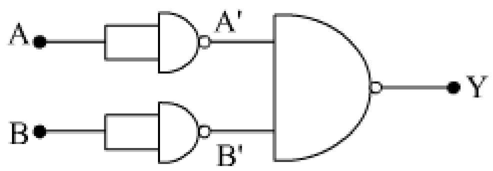


18.Draw a circuit diagram of n-p-n transistor amplifier in CE configuration. Under what condition does the transistor act as an amplifier?

19.In the given block diagram of a receiver, identify the boxes labeled as X and Y and write their functions.



20.In the circuit shown in the figure, identify the equivalent gate of the circuit and make its truth table.



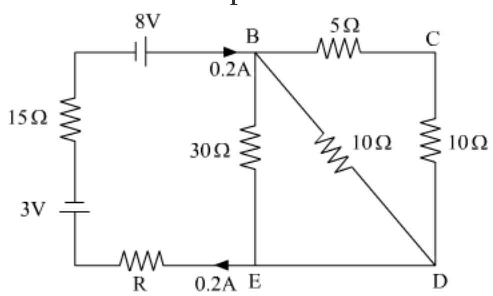
Section C (Short Answer Type Question Type 2)

21.Two point charges $q_1 = 10 \times 10^{-8}$ C and $q_2 = -2 \times 10^{-8}$ C are separated by a distance of 60 cm in air.
(i) Find at what distance from the 1st charge, q_1, would the electric potential be zero.
(ii) Also calculate the electrostatic potential energy of the system.

22.Two point charges $4Q$, Q are separated by 1 m in air. At what point on the line joining the charges is the electric field intensity zero? Also calculate the electrostatic potential energy of the system of charges, taking the value of charge, $Q = 2 \times 10^{-7}$ C.

23. Identify the following electromagnetic radiations as per the wavelengths given below. Write one application of each. (a) 10^{-3} nm (b) 10^{-3} m (c) 1 nm

24.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 b the potential difference between points B and E?



25. A wire AB is carrying a steady current of 12 A and is lying on the table. Another wire CD carrying 5 A is held directly above AB at a height of 1 mm. Find the mass per unit length of the wire CD so that it remains suspended at its position when left free. Give the direction of the current flowing in CD with respect to that in AB. [Take the value of $g = 10\ ms^{-2}$]

26. Using Biot-Savart law, deduce an expression for the magnetic field on the axis of a circular current loop. Hence obtain the expression for the magnetic field at the centre of the loop.

27. Draw a labelled ray diagram of a refracting telescope. Define its magnifying power and write the expression for it.
Write two important limitations of a refracting telescope over a reflecting type telescope. (3)

28. Write the principle of working of a potentiometer. Describe briefly, with the help of a circuit diagram, how a potentiometer is used to determine the internal resistance of a given cell.

29. Using Huygen's construction of a wavefront, explain the refraction of a plane wavefront at a plane

30. surface and hence verify Snell's law.

31. Describe briefly, with the help of labelled diagram, working of a step-up transformer.
A step-up transformer converts a low voltage into high voltage. Does it not violate the principle of conservation of energy? Explain.

32. Write the expression for the force acting on a charged particle of charge q moving with velocity $\vec{v}$ in the presence of magnetic field $\vec{B}$. Show that in the presence of this force
(i) the kinetic energy of the particle does not change
(ii) its instantaneous power is zero

33. (i) Out of blue and red light which is deviated more by a prism? Give reason.
(ii) Give the formula that can be used to determine refractive index of materials of a prism in minimum deviation condition.

34. Using Gauss's law in electrostatic, drive an expression for the electric field due to an infinitely long straight wire of linear charge density λ.

35. Using Bohr's postulates of the atomic model, derive the expression for radius of n^{th} electron orbit. Hence obtain the expression for Bohr's radius.

36. Write three basic properties of photons which are used to obtain Einstein's photoelectric equation. Use this equation to draw a plot of maximum kinetic energy of the electron emitted versus the frequency of the incident radiation.

37. Draw a circuit diagram to study the input and output characteristics of an n-p-n transistor in common emitter configuration. Show these characteristics graphically. Explain how(I) input resistance (ii)output resistance of the transistor are calculated by using these characteristics.

38. Define the term depletion layer and potential barrier for a p-n junction diode.
What is zener diode? Sketch the I-V characteristics curve, Explain with the help of suitable circuit diagram, the working of zener diode as regulator.

39. Mention three different modes of propagation used in communication system. Explain with the help of a diagram how long distance communication can be achieved by ionospheric reflection of radio waves.

40. Draw a block diagram of a simple amplitude modulator. Explain briefly how amplitude modulation is achieved.

41. Name the type of waves which are used for line of sight (LOS) communication. What is the range of their frequencies?
A transmitting antenna at the top of a tower has a height of 20 m and the height of the receiving antenna is 45 m. Calculate the maximum distance between them for satisfactory communication in LOS mode. (Radius of the Earth = 6.4×10^6 m)

Section E (long Answer Type Questions)

42.(a) Deduce the expression for the electrostatic energy stored in a capacitor of capacitance 'C' and having charge 'Q'.
(b) How will the (i) energy stored and (ii) the electric field inside the capacitor be affected when it is completely filled with a dielectric material of dielectric constant K?

43. Establish a relation between current and drift velocity.
Define relaxation time of the free electrons drifting in a conductor. How is it related to the drift velocity of free electrons? Use this relation to deduce the expression for the electrical resistivity of the material.

44. (a) In Young's double slit experiment, derive the expression for position of points having condition for (i) constructive interference and (ii) destructive interference on the screen.

(b) A beam of light consisting of two wavelengths, 800 nm and 600 nm is used to obtain the interference fringes in a Young's double slit experiment on a screen placed 1·4 m away. If the two slits are separated by 0·28 mm, calculate the least distance from the central bright maximum where the bright fringes of the two wavelengths coincide.

45.Draw a ray diagram to show the working of a compound microscope. Deduce an expression for the total magnification when the final image is formed at the near point.
(a) In a compound microscope, an object is placed at a distance of 1.5 cm from the objective of focal length 1.25 cm. If the eye piece has a focal length of 5 cm and the final image is formed at the near point, estimate the magnifying power of the microscope.

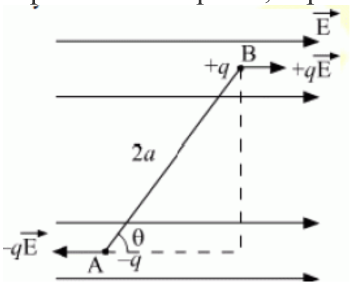
46.Describe briefly, with the help of a labelled diagram, the basic elements of an A.C. generator. State its underlying principle. Show diagrammatically how an alternating emf is generated by a loop of wire rotating in a magnetic field. Write the expression for the instantaneous value of the emf induced in the rotating loop.

47.(a) A series LCR circuit is connected to a source having voltage $v = v_m \sin \omega t$. Derive the expression for the instantaneous current I and its phase relationship to the applied voltage using phasor diagram.
(b) Obtain the condition for resonance to occur. Define ‘power factor’. State the conditions under which it is (i) maximum and (ii) minimum.

48.With the help of a neat and labeled diagram, explain the underlying principle, construction and working of a moving coil galvanometer. What is the function of (i) uniform radial field (ii) soft iron core in such a device?

49.**(a)** Using de Broglie’s hypothesis, explain with the help of a suitable diagram, Bohr’s second postulate of quantization of energy levels in a hydrogen atom.
(b) The ground state energy of hydrogen atom is −13.6 eV. What are the kinetic and potential energies of the electron in this state?

50.(a) Using Ampere’s circuital law, obtain the expression for the magnetic field due to a long solenoid at a point inside the solenoid on its axis.
(b) In what respect is a toroid different from a solenoid? Draw and compare the pattern of the magnetic field lines in the two cases.
(c) How is the magnetic field inside a given solenoid made strong?

Que. No.	**Model Answers**
1.	(i)electric potential (P.d), (ii) scalar quantity
2.	v is parallel or antiparallel to B
3.	The direction of induced current in a closed circuit is always such that it opposes the cause that produces it
4.	1:1
5.	Frequency
6.	1:2
8.	Gamma rays
9.	1:1
10.	Consider an electric dipole consisting of two equal and opposite point charges, −q at A and + q at B, separated by a small distance 2a.  AB = 2a, having dipole moment $\|\vec{p}\| = q(2a)$ Let this dipole be held in a uniform external electric field $\vec{E}$ at an angle □ with the direction of $\vec{E}$. Force on charge −q at A= − q $\vec{E}$, in a direction opposite to $\vec{E}$ Force on charge +q at B = +q $\vec{E}$, along the direction of $\vec{E}$ Net force on the dipole = qE − qE = 0 (ii) W = 2pE
11.	The magnetic moment m of a current loop is the vector whose magnitude is equal to the area of the loop times the magnitude of the current flowing in it i.e. $m = N IA$ Where, N = number of turns Let m_1 and m_2 be the magnetic moments of circular original coil of radius 'R' and new coil of radius 'R/2'. Length of wire remains same. Thus, $N(2\pi R) = N'\left(2\pi\left(\frac{R}{2}\right)\right)$ $N' = 2N$ Now,

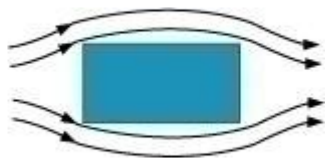
$$m_1 = NIA_1 = NI\left(\pi r_1^2\right) = NI\pi R^2$$

$$m_2 = N'IA_2 = 2NI\left(\pi r_2^2\right) = 2NI\left(\pi\left(\frac{R}{2}\right)^2\right) = \frac{1}{2}NI\pi R^2$$

$$\frac{m_2}{m_1} = \frac{\frac{1}{2}}{1} = \frac{1}{2}$$

12. (a) High retentivity: (b) High coercivity: Apart from these two criteria, the material should have high permeability.
(ii) The core of an electromagnet should have high permeability and low retentivity. Ferromagnetic materials have both high permeability and low retentivity. Hence, ferromagnetic materials are the most suitable for making the core of an electromagnet.

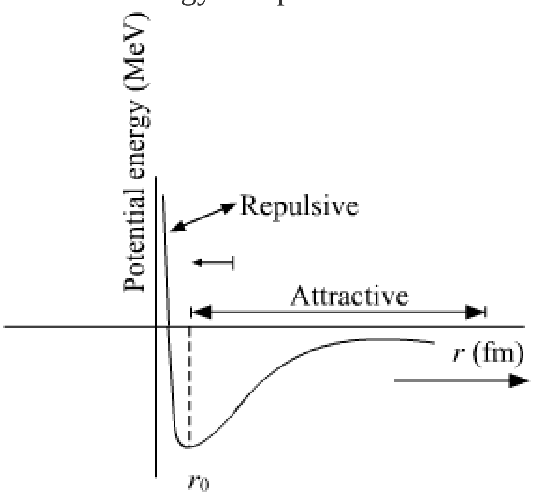
(i) The magnetic field lines, when a diamagnetic material is placed in an external magnetic field, can be diagrammatically represented as



(ii) The magnetic field lines, when a paramagnetic material is placed in an external magnetic field, can be diagrammatically represented as

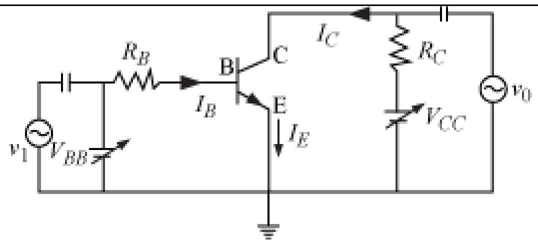
Diamagnetic and paramagnetic materials are distinguished by the magnetic property called magnetic susceptibility. For diamagnetic materials, magnetic susceptibility is negative, whereas for paramagnetic materials, magnetic susceptibility is slightly positive.

13. Potential energy of a pair of nuclear as a function of their separation:



	r_0 is the distance at which potential energy is minimum. For a separation greater than r_0, the force is attractive and for separations less than r_0 the force is strongly repulsive. Characteristic features of nuclear forces are- (i) Nuclear forces are much stronger then coulomb forces acting between charges or the gravitational forces between masses. (ii) The nuclear force between neutron-neutron, proton-neutron and proton-proton is approximately the same. The nuclear force does not depend on the electric charge.
14.	The law of radioactive decay states that the number of nuclei undergoing the decay per unit time is proportional to the total number of nuclei in the given sample. The law of radioactive decay is given by: $N(t) = N_0 e^{-\lambda t}$ $N(t) \longrightarrow$ Number of nuclei left after time t $N_0 \longrightarrow$ Original number of nuclei. $\lambda \longrightarrow$ Decay constant $t \longrightarrow$ Time Now, $N = N_0 e^{-\lambda t}$ At $t = t_{\frac{1}{2}}, N = \frac{N_0}{2}$ $\Rightarrow \frac{N_0}{2} = N_0 e^{-\lambda t_{\frac{1}{2}}}$ $\Rightarrow e^{\lambda t_{\frac{1}{2}}} = 2$ Taking ln on both sides, we obtain $\ln\left(e^{\lambda t_{\frac{1}{2}}}\right) = \ln_2$ $\lambda t_{\frac{1}{2}} = \ln_2$ $\boxed{t_{\frac{1}{2}} = \frac{\ln_2}{\lambda}}$ Hence, the relation between half-life period and disintegration constant of a radioactive nucleus is established.
15.	The focal length of a combined lens can be determined by the formula

	$\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$ Here, $R_2=\infty$ and $f=0.3$ m $\frac{1}{0.3}=(\mu-1)\times\frac{1}{R_1}$ $R_1=0.3(\mu-1)$ $=0.3(1.5-1)$ $=0.3\times 0.5$ $=0.15$ m $=15$ cm
16.	By using Gauss's Law. It is given as $\Phi=\oint \vec{E}\cdot d\vec{s}=\frac{q}{\epsilon_0}$ Now, the flux passing through all the six surfaces would be $\Phi=6\phi=\frac{q}{\epsilon_0}$ And the flux passing through each surface would be $\phi=\frac{q}{6\epsilon_0}$
17.	$\lambda=\frac{h}{\sqrt{2meV}}$ $\lambda=\frac{h}{\sqrt{2e}\cdot\sqrt{m}}\cdot\frac{1}{\sqrt{V}}$ $\frac{1}{\sqrt{m}}=\frac{\sqrt{2e}\sqrt{V}}{h}\lambda$ $\frac{1}{\sqrt{m}}=\frac{\sqrt{2e}}{h}\left(\frac{\lambda}{\frac{1}{\sqrt{V}}}\right)$ $\therefore \frac{1}{\sqrt{m}}=\frac{\sqrt{2e}}{h}\times$ (Slope of λ and $\sqrt{V}$ graph) $\because$ Slope of B > Slope of A $\frac{1}{\sqrt{M_B}}>\frac{1}{\sqrt{M_A}}\Rightarrow\sqrt{M_B}<\sqrt{M_A}$ $\therefore M_B<M_A$ • Therefore, line *B* represents a particle of smaller mass.
18.	The circuit diagram of an NPN transistor amplifier in CE configuration is given below:

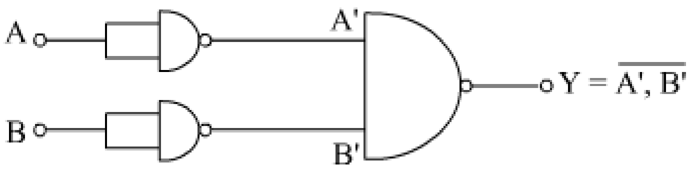


The transistor acts as an amplifier when the input circuit (emitter–base) is forward biased with low voltage V_{BB} and the output circuit (collector–base) is reverse biased with high voltage V_{CC} .

19. Solution:

X → IF stage → Intermediate frequency stage to change the carrier frequency to lower frequency.
Y → Amplifier → It amplifies the signal i.e. it increase the amplitude of the detected signal to compensate the attenuation of the signal. The detected signal may not be strong enough to use.

20. Solution:



$Y = \overline{\overline{A}.\overline{B}} = \overline{\overline{A}} + \overline{\overline{B}} = A + B$

Truth table

A	B	$A' = \overline{A \cdot A}$	$B' = \overline{B \cdot B}$	$Y = \overline{A' \cdot B'}$
0	0	1	1	0
0	1	1	0	1
1	0	0	1	1
1	1	0	0	1

Thus the equivalent gate is OR gate.

21. Here, $q_1 = 10 \times 10^{-8}$ C, $q_2 = -2 \times 10^{-8}$ C
And AB = 60 cm = 0.60 = 0.6 m
Let $AP = x$
Then, $PB = 0.6 - x$

Potential P due to charge $q_1 = \frac{kq_1}{AP}$

Potential P due to charge $q_2 = \frac{kq_2}{PB}$

∵ Potential at $P = 0 \Rightarrow \frac{kq_1}{AP} + \frac{kq_2}{PB} = 0$

22.

$$\frac{kq_1}{AP} = -\frac{kq_2}{PB} \Rightarrow \frac{q_1}{AP} = -\frac{q_2}{PB}$$

$$\therefore \frac{10\times10^{-8}}{x} = \frac{-\left(2\times10^{-8}\right)}{0.6-x} \Rightarrow \frac{10}{x} = \frac{2}{0.6-x}$$

$$2x = 6.0 - 10x \Rightarrow 2x + 10x = 6$$

$$\therefore 12x = 6 \Rightarrow x = \frac{6}{12} = 0.5 \text{ m}$$

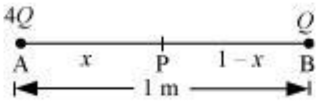
∴Distance from first charge = 0.5 = 50 cm

(ii) Electrostatic potential energy of the system

$$U = k\frac{q_1q_2}{r}$$

$$U = 9\times10^9 \times \frac{10\times10^{-8}\times\left(-2\times10^{-8}\right)}{0.6}$$

$$U = \frac{-18\times10^{-6}}{0.6} \Rightarrow U = -30\times10^{-6} = -3\times10^{-5} \text{ J}$$



Let the point be at a distance x from $4Q$ charge.

Electric field at P due to $4Q$ = Electric field at P due to Q

$$\therefore k = \frac{4Q}{x^2} = k\times\frac{Q}{(1-x)^2}$$

$$\frac{4}{x^2} = \frac{1}{(1-x)^2} \Rightarrow \frac{2}{x} = \pm\frac{1}{1-x}$$

$$\frac{2}{x} = \frac{1}{1-x} \text{ or } \frac{2}{x} = -\frac{1}{1-x}$$

$x = 2 - 2x$ or $-x = 2 - 2x$

$x + 2x = 2$ or $-x + 2x = 2$

$3x = 2$ or $x = 2$

$x = \frac{2}{3}$ or $x = 2$

∵ $x = 2$ m is not possible

$\therefore x = \frac{2}{3}$ m

Electrostatic potential energy of the system is

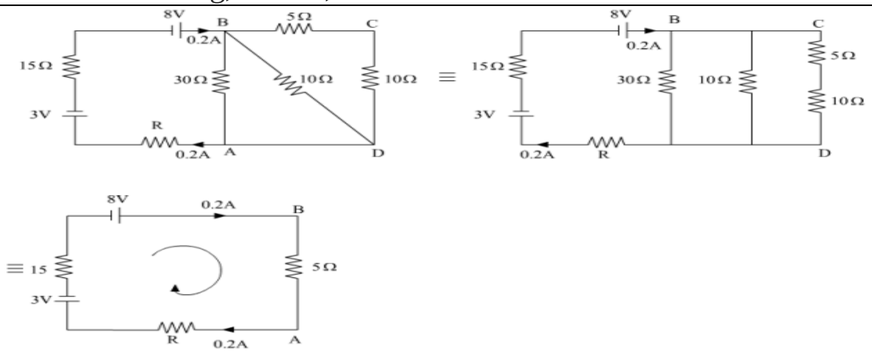
$$U = k\frac{q_1q_2}{r}$$

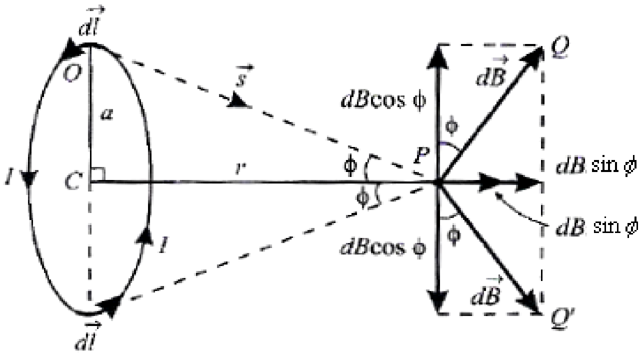
$$\Rightarrow U = k\cdot\frac{4Q\cdot Q}{r} = k\frac{4Q^2}{r}$$

$$U = 9\times10^9\times\frac{4\times\left(2\times10^{-7}\right)^2}{1}$$

$$U = 9\times10^9\times\frac{4\times4\times10^{-14}}{1}$$

$$U = 144\times10^{-5} = 1.44\times10^{-3}\text{ J}$$

23.	(a) Wavelength range: 10^{-3} nm = $10^{-3} \times 10^{-9} = 10^{-12}$ m Type of EMW: X-rays Applications: X-rays are used in surgery for the detection of fractures, foreign bodies such as bullets, diseased organs and stones in human body. (b) Wavelength range: 10^{-3} m Type of EMW: Microwave Application: Microwaves are used in Radar systems for aircraft navigation. (c) Wavelength range: 1 nm Type of EMW: Infrared Application: Infrared waves are used for taking photographs during the conditions of fog, smoke, etc.
24.	 Apply Kirchhoff's Law:- 5(0.2) + R (0.2) + 15(0.2) = 8 − 3 ⇒ R = 5Ω V_{BE} = 5(0.2) = 1V
25.	Force per unit length between the current carrying wires is given as: $F = \frac{\mu_o}{4\pi}\frac{2I_1I_2}{r}$ Let m be the mass per unit length of wire CD. As the force balances the weight of the wire. $\therefore \frac{\mu_o}{4\pi}\frac{2I_1I_2}{r} = mg$ Here, m is mass per unit length. $\Rightarrow 10^{-7} \times \frac{2\times12\times5}{1\times10^{-3}} = m\times10$ $\Rightarrow m = 10^{-7} \times \frac{2\times12\times5}{1\times10^{-3}} \times \frac{1}{10} = 1.2\times10^{-3}$ kg m^{-1} Direction : opposite to each other
26.	Consider a circular loop of wire of radius *a* and carrying current *I*, as shown in figure.



Let the plane of the loop be perpendicular to the plane of paper. We wish to find field $\vec{B}$ at an axial point P at a distance r from the centre C.

Consider a current element $d\vec{l}$ at the top of the loop. It has an outward coming current.

If $\vec{s}$ be the position vector of point P relative to the element $d\vec{l}$, then from Biot-Savart law, the field at point P due to the current element is

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

Since $d\vec{l} \perp \vec{s}, i.e., \theta = 90^\circ$, therefore

$$dB = \frac{\mu_0}{4\pi}\frac{Idl}{s^2}$$

The field $d\vec{B}$ lies in the plane of paper and is perpendicular to $\vec{s}$, as shown by PQ.Let ϕ be the angle between OP and CP. Then dB can be resolved into two rectangular components.

1. $dB\sin\phi$ along the axis,
2. $dB\cos\phi$ perpendicular to the axis.

For any two diametrically opposite elements of the loop, the components perpendicular to the axis of the loop will be equal and opposite and will cancel out. Their axial components will be in the same direction, i.e., along CP and get added up.

Therefore, total magnetic field at the point P in the direction CP is

$$B = \int dB\sin\phi$$

$$\text{But} \sin\phi = \frac{a}{s} \text{ and } dB = \frac{\mu_0}{4\pi}\frac{Idl}{s^2}$$

$$\therefore B = \int \frac{\mu_0}{4\pi}.\frac{Idl}{s^2}.\frac{a}{s}$$

Since μ_0 and I are constant, and s and $a$are same for all points on the circular loop, we have

$B =$

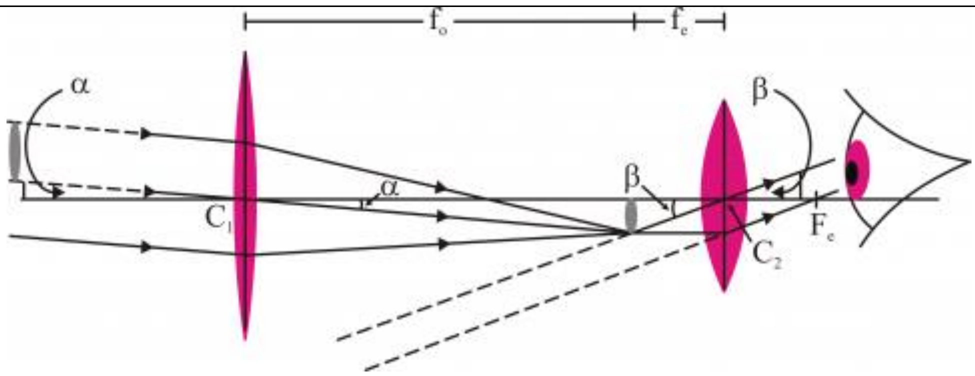
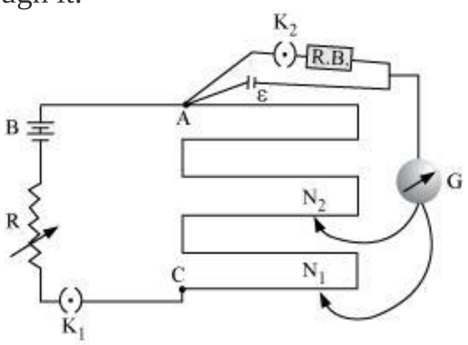
$$\frac{\mu_0 Ia}{4\pi s^3}\int dI = \frac{\mu_0 Ia}{4\pi s^3}.2\pi a = \frac{\mu_0 I a^2}{2s^3} \qquad [\because \int dI = Circumference = 2\pi a]$$

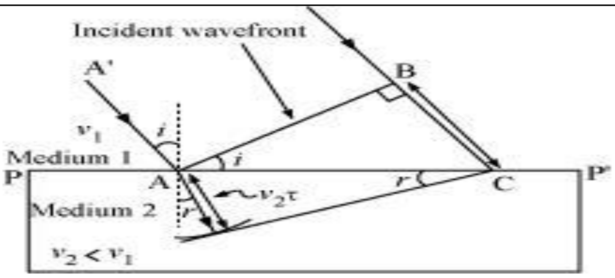
$$As, \qquad s = (r^2 + a^2)^{1/2}$$

$$\therefore \quad B = \frac{\mu_0 I a^2}{2(r^2+a^2)^{3/2}}$$

If the coil consists on N turns, then $B = \dfrac{\mu_0 N I a^2}{2(r^2+a^2)^{3/2}}$.

Magnetic field at the centre: For the field at the centre of the loop, $r = 0$.

	Therefore $$B = \frac{\mu_0 N I}{2a}$$
27.	 Magnifying power is defined as the ratio of angle subtended by the image on the lens to the object on the lens or eye. M = - f_0/ f_e (i) Chromatic aberration. (ii) Spherical aberation.
28.	Potential drop across any portion of the wire is directly proportional to the length of the wire provided the wire is of uniform area of cross section and constant current is flowing through it.  Let Φ be the potential drop per unit length in the potentiometer wire. When only a cell is connected, the balance point is N_1. Appling Kirchhoff's voltage law, ε = Φ l_1 [l_1 = Length at which the balance point is achieved] When some current is drawn using the resistance box, the balance point is achieved at N_2. $V = \Phi l_2$ This gives, $\frac{\varepsilon}{V} = \frac{l_1}{l_2}$ ε = *I* (*r* + *R*) [*R* = Resistance of the resistance box] $V = IR$ This gives, $\frac{\varepsilon}{V} = \frac{r+R}{R}$ $r = R\left(\frac{l_1}{l_2} - 1\right)$ The internal resistance of the cell can be determined by plugging-in the

	measured values of l_1 and l_2.
29.	 Wavefront AB strikes the surface PP′ with an angle of incidence 'i'. Speed of light in medium 1 is v_1. Speed of light in medium 2 is v_2. Let 'τ' be the time taken by the wavefront to travel the distance BC. BC = $v_1\tau$ $\sin i = \frac{BC}{AC} = \frac{v_1\tau}{AC}$ ...(i) $\sin r = \frac{AE}{AC} = \frac{v_2\tau}{AC}$ ...(ii) Dividing (i) by (ii), we obtain $\frac{\sin i}{\sin r} = \frac{v_1}{v_2}$ ...(iii) Refractive index(n_1) of medium 1 is $\frac{c}{v_1}$ $\Rightarrow v_1 = \frac{c}{n_1}$ Refractive index (n_2)of medium 2 is $\frac{c}{v_2}$ $\Rightarrow v_2 = \frac{c}{n_2}$ Putting these values in equation (iii), $\frac{\sin i}{\sin r} = \frac{\frac{c}{n_1}}{\frac{c}{n_2}} = \frac{n_2}{n_1}$ $\frac{\sin i}{\sin r} = \frac{n_2}{n_1}$ (Snell's Law)
30.	In a transformer with N_s secondary turns and N_p primary turns, induced *emf* or voltage E_s is: $E_s = -N_s \frac{d\phi}{dt}$ Back *emf* = E_p = $-N_p \frac{d\phi}{dt}$ $E_P = V_P$ $E_s = V_s$

	Thus, $V_s = -N_s \frac{d\phi}{dt}$ … (i) $V_p = -N_p \frac{d\phi}{dt}$ ...(ii) Dividing equations (i) and (ii), we obtain $\frac{V_s}{V_p} = \frac{N_s}{N_p}$ If the transformer is 100% efficient, then $i_p v_p = i_s v_s = \text{Power }(p)$ Thus, combining the above equations, $\frac{i_p}{i_s} = \frac{v_s}{v_p} = \frac{N_s}{N_p}$ Or, $V_s = \left(\frac{N_s}{N_p}\right) V_p$ and $I_s = \left(\frac{N_p}{N_s}\right) I_p$ If $N_s > N_p$, then the transformer is said to be step-up transformer because the voltage is stepped up in the secondary coil. Power consumed in both the coils is the same as even if the voltage increases or current increases, their product at any instant remains the same.
31.	$\vec{F} = q(\vec{V} \times \vec{B})$ (i) $\vec{F}$ is perpendicular to both $\vec{u}$ and $\vec{B}$. If $\vec{ds}$ is the instantaneous displacement of the charge, $\vec{ds}$ is also perpendicular to $\vec{F}$. Work done (*W*) by this force ($\vec{F}$) = Increase in kinetic energy (K.E.) $W = \vec{F} \cdot \vec{ds}$ $= Fds \cos 90°$ $W = 0$ Hence, increase in K.E. = 0 ∴ The K.E. of the particle does not change. (ii) Power $= \vec{F} \cdot \vec{v}$ $= Fv \cos 90°$ Power = 0
32.	(i) Between blue and red light, blue light is deviated more by a prism. This is because the wavelength of blue light is smaller than that of red light. Therefore, the speed of blue light is lower than that of red light in a medium. (ii) The formula used for determining the refractive index of materials of a prism in minimum deviation condition, $n_{21} = \frac{\sin[(A+D_m)/2]}{\sin\left[\frac{A}{2}\right]}$ Where, $n_{21} \longrightarrow$ Refractive index of prism material with respect to the surrounding medium $A \longrightarrow$ Angle of the prism $D_m \longrightarrow$ Angle of minimum deviation

33. Consider a thin infinite long positively charged straight long conductor of linear charge density

λ = q / *l* - - - -(1).

We have to find electric field intensity at point P, which is at distance 'r' from the plate.

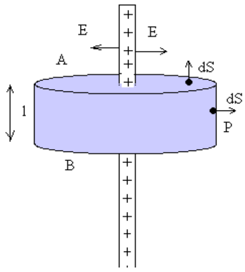
With conductor as an axis we will draw an imaginary cylinder of radius 'r' & length '*l*' it is called Gaussian surface & point 'P' lies on it. Electric field at each point on the conductor is same & directed perpendicularly outward.

From Gauss's theorem the outward flux through the Gaussian surface is

(i)Flux through the plane surfaces A & B is minimum because area vector is perpendicular to the field i.e. θ = 90°

hence minimum lines pass through it

$\phi_1 = \phi_2 = \oint_s E\ dS \cos 90 = 0$ --------(1)



Due to same reason flux through plane surface B is also zero.

(ii)Flux through the curved surface is maximum because area vector is parallel to the field i.e. θ = 0 hence maximum lines pass through it.

$\phi_3 = \oint_s E\ dS \cos 0 = E \oint_s dS \quad \Rightarrow \phi_3 = E \times 2\pi r l \ - - - \ (2)$

Hence net outward flux through the Gaussian surface is $\phi = \phi_1 + \phi_2 + \phi_3$

From eq 1 & 2,

$\phi = 0 + 0 + E \times 2\pi r l \qquad \Rightarrow \phi = 2\pi r l E \ - - - (3)$

From Gauss's theorem $\phi = \dfrac{q}{\varepsilon_0} \ - - - - (4)$

Comparing eq3 & 4

$2\pi r l E = \dfrac{q}{\varepsilon_0} \qquad \Rightarrow E = \dfrac{q}{2\pi\varepsilon_0 l r} \quad hence E = \dfrac{\lambda}{2\pi\varepsilon_0 r}$

34. According to the postulates of Bohr's atomic model, the electrons revolve around the nucleus only in those orbits for which the angular momentum is the integral multiple of $h2\pi$.

$\therefore L = nh2\pi$

Angular momentum is given by

$L = mvr$

According to Bohr's 2nd postulate,

$L_n = mv_n r_n = \dfrac{nh}{2\pi}$

$n \longrightarrow$ Principle quantum

$v_n \longrightarrow$ Speed of moving electron in the n^{th} orbit

$r_n \longrightarrow$ Radius of n^{th}orbit

$v_n = \dfrac{e}{\sqrt{4\pi \epsilon_0 m r_n}}$

$\therefore v_n = \dfrac{1}{n} \dfrac{e^2}{4\pi\epsilon_0} \dfrac{1}{\left(\dfrac{h}{2\pi}\right)}$

$\therefore r_n = \left(\dfrac{n^2}{m}\right)\left(\dfrac{h}{2\pi}\right)^2 \dfrac{4\pi\epsilon_0}{e^2}$

For $n = 1$ (innermost orbit),

$$r_1 = \frac{h^2 \epsilon_0}{\pi m e^2}$$

This is the expression for Bohr's radius.

35. **Propreties of photon :**

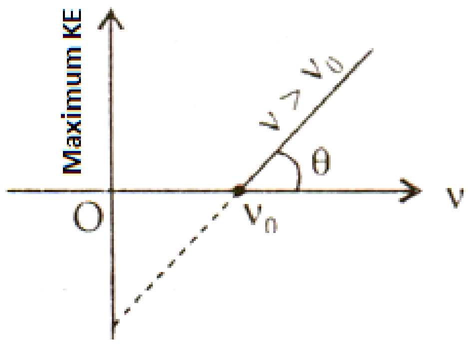
- Each photon has fixed energy and momentum,
- photons not deflected by electric field and magnetic field,
- in photon electron collision the total energy and momentum is conserved.

Photo electric equation is given by

Eq ----- $h\nu = h\nu_0 + e V_0$

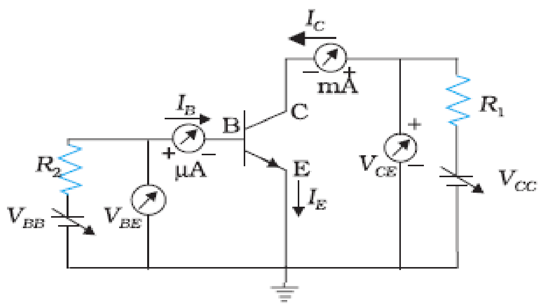
Also $h\nu = h\nu0 + K_{max}$

Graph between maximum K.E. and frequency of incident radiation



36.

. Circuit diagram of n-p-n transistor(CE):

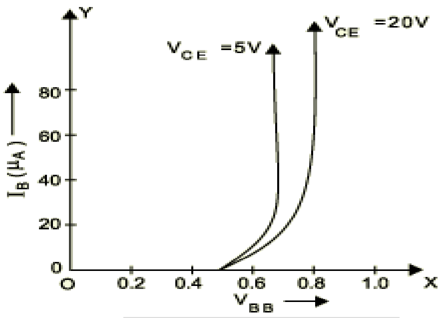


(a)<u>Input Characteristics</u>: -

The graph between base-emitter (input) voltage V_{be} and base (input) current I_b when the collector-emitter (output) voltage is kept constant is called input characteristics curve.

Keeping V_{ce} = 5V (Constant) if we make V_{be} zero then base current is zero. As we increase V_{be} the I_b still remain zero.

When the base voltage becomes greater than potential barrier a minute base current flows. As V_{be} increases the I_b initially increases slowly and then suddenly increases rapidly because the potential barrier is completely removed. Similarly for different value of V_{ce} the similar curve obtained. The input characteristics are not much affected by small change in V_{ce}. The input resistance r_i is define as the slope of the characteristics at any point $r_i = \left(\frac{\Delta V_{be}}{\Delta I_b}\right)_{at\ Constant\ V_{ce}}$

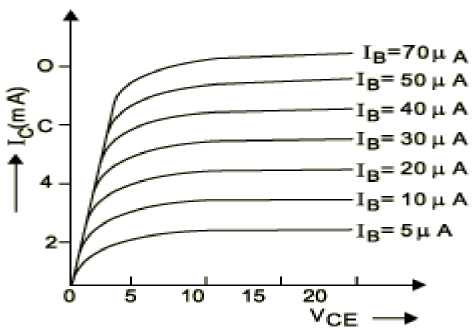


Input characteristics of common emitter transistor

Output Characteristics: - The graph between collector-emitter (output) voltage V_{be} and collector (output) current I_c when the base (input) current is kept constant is called output characteristics curve.

Keeping I_b = 10 μA. (Constant) if we make V_{ce} zero then collector current is zero. As we increase V_{ce} ,

I_c increases since small charge carriers are collected. As V_{ce} increases almost all the charge carriers supplied by the input are collected so after some time current Ic become constant and graph become parallel to the voltage axis. As I_b increases I_c also increases and become constant the graph is similar. As more charge carriers are supplied by the input so more carriers are collected in collector, which increase I_c.



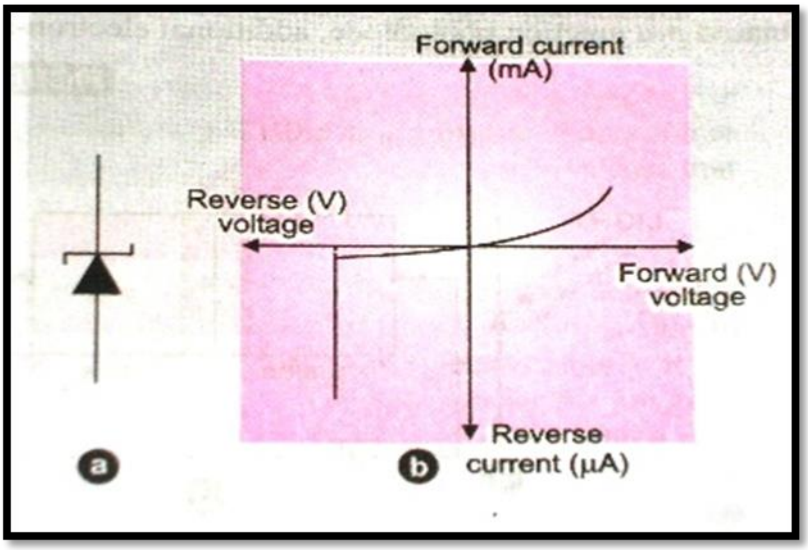
Output characteristics of the common emitter transistor

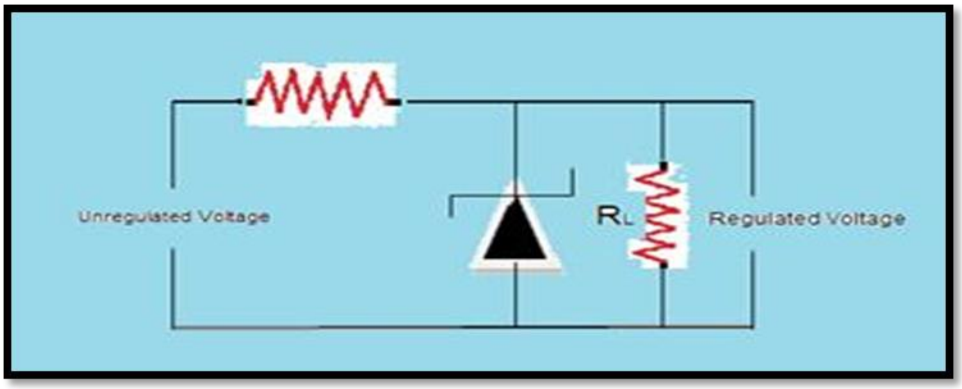
37 Depletion region: The small region in the vicinity of the junction which is depleted of free charge carries and has only immobile ions is called depletion region

Potential barrier: The accumulation of negative immobile charges in the p-region and positive immobile charges in the n- region set up as a potential difference across the junction. This acts as a barrier and is called a potential barrier.

Zener diode: The junction diode specially designed to operate only in the reverse breakdown region continuously(without getting damaged) is called zener diode.

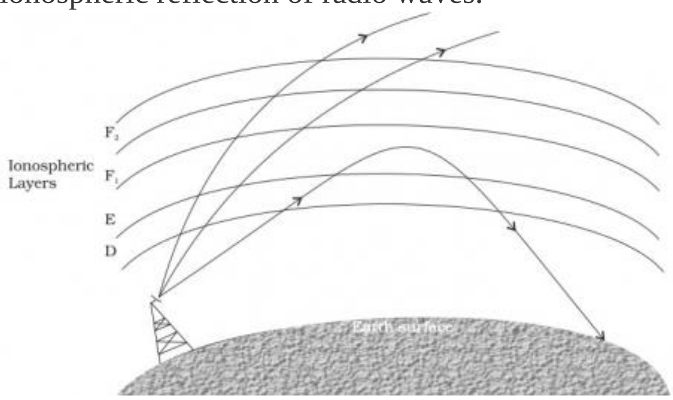
I-V Characteristics curve:





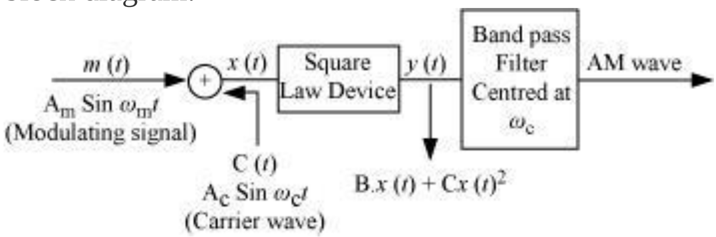
A zener diode has unique feature that voltage drop across it , is independent of current through it.
When the input d.c.voltage across zener diode increase beyond a certain limit i.e. zener voltage , the current through the circuit rises sharply , causing a sufficient increase in voltage drop across the dropping resistor R. As a result of it the voltage across zener diode remain constant and hence the output voltage lower back to normal value.

38. Three modes of propagation of electromagnetic waves,
(a) Ground waves,(b) Sky waves,(c) Space waves.
Sky wave propagation is used for long distance communication by ionospheric reflection of radio waves.



In the ionosphere of the Earth's atmosphere, there are a large number of charged particles (ions). The ionosphere is situated about 65 km – 400 km above the surface of the Earth. The ionization of molecules occurs due to the absorption of the ultraviolet rays and high energy radiation from the Sun. The ionosphere acts as a reflecting layer for certain range of frequencies (3MHz-30MHz). The transmitting antenna sends the EM signals of this frequency range towards the ionosphere. When the EM waves strikes the ionosphere, it is reflected back to the Earth. A receiving antenna at a remote location on the Earth receives these reflected signals.

39. A conceptually simple method to produce AM wave is shown in the following block diagram.



Here the modulating signal $A_m \sin w_m t$ is added to the carrier signal $A_c \sin w_c t$ to produce the signal $x(t)$. This signal $x(t) = A_m \sin w_m t + A_c \sin w_c t$ is passed through a square law device, which produces an output.

$y(t) = B\,x(t) + Cx^2(t)$

Where, B and C are constants

This signal is then passed through a band pass filter, which rejects dc. The output of the band pass filter is, therefore, an AM wave.

40. Space wave are used for the line of sight (LOS) communication.

The range of their frequencies is 40 MHz and above.

We have, height of transmitting antenna, $h_T = 20$ m and height of receiving antenna, $h_R = 45$ m

Then, Maximum distance between the two antennas,

$$d_m = \sqrt{2Rh_T} + \sqrt{2Rh_R}$$

$$\Rightarrow d_m = \sqrt{2\times 6.4\times 10^6 \times 20} + \sqrt{2\times 6.4\times 10^6\times 45} = 2\times 8\times 10^3 + 3\times 8\times 10^3 = 40 \text{ km.}$$

Thus, the maximum distance between the antennas is 40 km.

42 Energy stored in a charged capacitor. The energy of a charged capacitor is measured by the total work done in charging the capacitor to a given potential

we know that capacitance is $C = \frac{q}{V}$ where $q$is the charge on the plates and V is potential difference.

When an additional amount of charge dq is transferred from negative to positive plate, the small work done is given by $dw = V dq = \frac{q}{C} dq$

The total work done in transferring total charge Q is given by

$$w = \int_0^Q \frac{q}{c} dq = \frac{1}{C}\int_0^q q\,dq = \frac{1}{C}\left[\frac{q^2}{2}\right]_0^Q = \frac{1}{C}\left[\frac{Q^2}{2} - 0\right]$$

$$= \frac{Q^2}{2C}$$

This work is stored as electrostatic potential energy U in the capacitor.

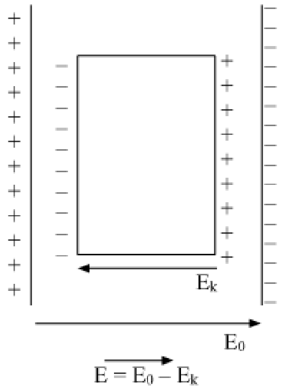
$$U = \frac{Q^2}{2C}$$

$$\text{or } U = \frac{(CV)^2}{2C} \qquad [\because Q = CV]$$

$$\text{or } U = \frac{1}{2}CV^2$$

$$\text{or } U = \frac{1}{2}QV$$

(b) When dielectric material of dielectric constant 'k' is introduced inside the capacitor then
(ii) Electric field is reduced



$$\frac{E_0}{E} = k$$

$$\text{But } k > 1 \text{ so } \frac{E_0}{E} > 1 \text{ or } E_0 > E$$

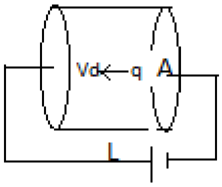
When dielectric is introduced in capacitor opposite charge is induced on the plates of dielectric as a result of which an electric field is induced which is in opposite direction. Thus, Net electric field is reduced.
(i) Again, $V_0 = E_0 d$ ... (1)
Where V_0 is the potential when there is vacuum between the plates of the capacitor and d is the separation between the plates of the capacitor,
When dielectric is introduced, potential difference is given by
V = Ed ... (2)
Dividing (1) & (2)

$$\frac{V_0}{V} = \frac{E_0}{E} = k$$

But $k > 1 \therefore V_0 > V$
Thus potential difference also decreases.

We have energy stored as $U = \frac{1}{2}QV$ Since V decreases, U also decreases.

43. (a)



Let n = no density of free electrons

Ans : current flowing in a conductor $I = \frac{q}{t} = \frac{neAlv_d}{\frac{l}{v_d}}$ $or\ I = neAv_d$

(b)

Relaxation time (τ), it is the short time for which a free electron accelerates before it undergoes a collision with the positive ion in the conductor. Or, we can say it is the average time elapsed between two successive collisions. It is of the order 10^{-14} s. It decreases with increase of temperature and is given as

$$\vec{v}_d = \vec{a}\tau$$

$$\text{or}\ \vec{v}_d = -\frac{eE}{m}\tau \qquad \left[\because \vec{a} = \frac{-e\vec{E}}{m}\right]$$

Where $\vec{v}_d$ is the drift velocity E is the applied electric field. *e* and *m* are the charge and mass of electron respectively.
Again consider the conductor with length *l* and A as area of cross-section.
Let *n* be the number of electrons per unit volume in the conductor.

$v_d = -\frac{eE}{m}\tau$ (Magnitude of drift velocity)

The current flowing through the conductor due to drift
I = $neAv_d$
Substituting value of $\square_d$

$$I = nA\left(\frac{eE\tau}{m}\right)e$$

$$I = \frac{nAe^2E\tau}{m}$$

If V is potential difference applied across the two ends then

$E = \frac{V}{l}$ put in above equation

$$\text{So}\ I = \frac{nAe^2V\tau}{ml}$$

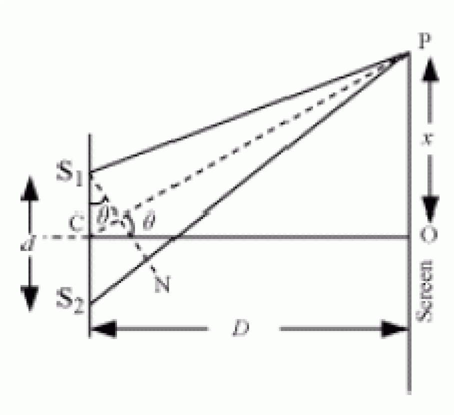
$$\frac{V}{I} = \frac{ml}{ne^2\tau A}$$

Now, According to ohm's law $\frac{V}{I} = R$ (Resistance of conductor)
Thus,

$$R = \frac{m}{ne^2\tau}\cdot\frac{l}{A}$$

Compare this with formula of resistance $R = \rho\cdot\frac{l}{A}$
Where □ is the resistivity of the material we get

$$\rho = \frac{m}{ne^2\tau}$$

	Thus electrical resistivity depends inversely on the relaxation time τ.
44	a) Young's double slit experiment: Consider two narrow rectangular slits S_1 and S_2 placed perpendicular to the plane of paper. Slit S is placed on the perpendicular bisector of S_1S_2 and is illuminated with monochromatic light. The slits are separated by a small distance *d*. A screen is placed at a distance *D* from S_1, S_2.  Consider a point P on the screen at distance *x* from O. The path difference between the waves reaching P from S_1 and S_2 is: $P = S_2P - S_1P$ Draw S_1N perpendicular to S_2P. Then, $P = S_2P - S_1P = S_2P - NP = S_2N$ From right-angled $\Delta S_1S_2N, \frac{S_2N}{S_2S_1} = \sin\theta$ $\therefore P = S_2N = S_2S_1 \sin\theta = d\sin\theta$ From triangle COP, When angle is small, $\sin\theta \approx \theta \approx \tan\theta = \frac{x}{D}$ $\therefore P = \frac{xd}{D}$ For constructive interference, $\frac{xd}{D} = n\lambda, n = 0,1,2,3,...$ Position of n^{th} bright fringe, $x_n = \frac{nD\lambda}{d} = 0, \frac{D\lambda}{d}, \frac{2D\lambda}{d}, \frac{3D\lambda}{d}, ...$ When $n = 0$, $x_n = 0$, central bright fringe is formed at O. For destructive interference, $\frac{xd}{D} = (2n+1)\frac{\lambda}{2}$ or $x_n = (2n+1)\frac{\lambda D}{2d} = \frac{1}{2}\frac{\lambda D}{d}, \frac{3}{2}\frac{\lambda D}{d}, \frac{5}{2}\frac{\lambda D}{d}, ...$ Thus, alternate bright and dark fringes are formed on the screen. (b) Given: − $\lambda_1 = 800$ nm $= 800 \times 10^{-9}$ m $\lambda_2 = 600$ nm $= 600 \times 10^{-9}$ m D = 1.4 m $d = 0.28$ mm $= 0.28 \times 10^{-3}$ m Let n_1^{th} maximum corresponds to □$_1$ coincides with n_2^{th} maximum corresponds to □$_2$. Then,

$$n_1 \frac{\lambda_1 D}{d} = n_2 \frac{\lambda_2 D}{d}$$

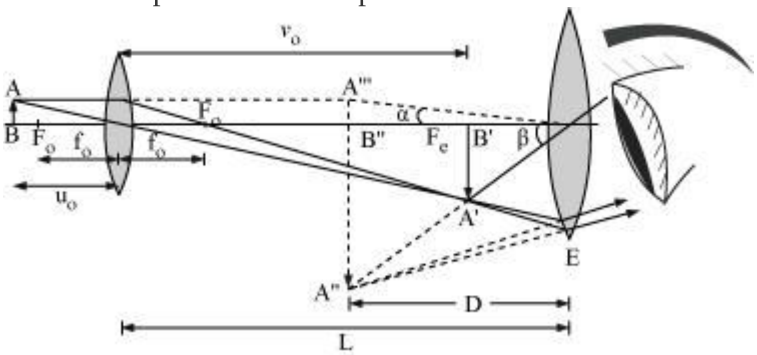
$$\text{or, } \frac{n_1}{n_2} = \frac{\lambda_2}{\lambda_1} = \frac{600}{800} = \frac{3}{4}$$

The minimum integral value of n_1 is 3 and of n_2 is 4. Therefore, the minimum value of y is,

$$y_{\min} = n_1 \frac{\lambda_1 D}{d} = \frac{3 \times 800 \times 10^{-9} \times 1.4}{0.28 \times 10^{-3}}$$

$$y_{\min} = 12 \text{ mm}$$

45. Ray diagram for a compound microscope



Total angular magnification, $m = \frac{\beta}{\alpha}$

β ⟶ Angle subtended by the image

α ⟶ Angle subtended by the object

Since α and β are small,

$\tan \alpha \approx \alpha$ and $\tan \beta \approx \beta$

$$m = \frac{\tan \beta}{\tan \alpha}$$

$$\tan \alpha = \frac{AB}{D}$$

And

$$\tan \beta = \frac{A''B''}{D}$$

$$m = \frac{\tan \beta}{\tan \alpha} = \frac{A''B''}{D} \times \frac{D}{AB} = \frac{A''B''}{AB}$$

On multiplying the numerator and the denominator with A′B′, we obtain

$$m = \frac{A''B'' \times A'B'}{A'B' \times AB}$$

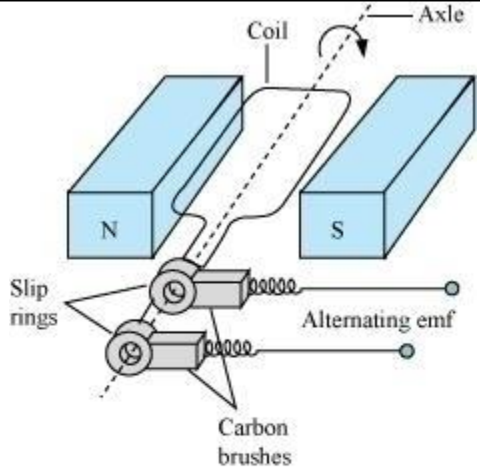
Now, magnification produced by objective, $m_0 = \frac{A'B'}{AB}$

Magnification produced by eyepiece, $m_e = \frac{A''B''}{AB}$

Therefore,

Total magnification, $(m) = m_0 \, m_e$

	$m_0 = \frac{v_0}{u_0} = \frac{\text{(Image distance for image produced by objective lens)}}{\text{(Object distance for the objective lens)}}$ $m_e = \left(1 + \frac{D}{f_e}\right)$ $f_e \rightarrow$ Focal length of eyepiece $m = m_0 m_e$ $= \frac{v_0}{u_0}\left(1 + \frac{D}{f_e}\right)$ $v_0 \approx L$ (Separation between the lenses) $u_0 \approx -f_0$ $\therefore m = \frac{-L}{f_0}\left(1 + \frac{D}{f_e}\right)$ $u_0 = -1.5$ cm $f_0 = +1.5$ cm $\frac{1}{f_0} = \frac{1}{v_0} - \frac{1}{u_0}$ $\frac{1}{1.25} = \frac{1}{v_0} + \frac{1}{1.5}$ $\frac{1}{v_0} = \frac{1}{1.25} - \frac{1}{1.5}$ $= \frac{100}{125} - \frac{10}{15}$ $= \frac{1500 - 1250}{1875}$ $\frac{1}{v_0} = \frac{250}{1875}$ $v_0 = +7.5$ cm $f_e = +5$ cm $m = \frac{v_0}{u_0}\left(1 + \frac{D}{f_e}\right)$ $= \frac{7.5}{-1.5}\left(1 + \frac{25}{5}\right)$ $= -\frac{7.5}{1.5} \times 6$ $\boxed{m = -30}$
46	Basic elements of an A.C. generator

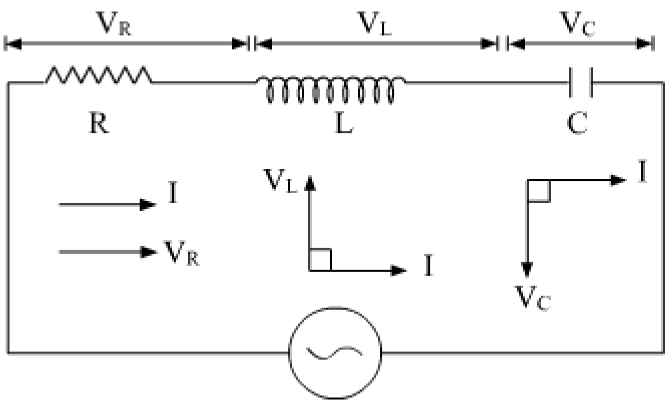


An A.C. generator consists of a rotor shaft on which a coil is mounted. A magnetic field is created around an armature coil with the help of permanent magnets.
The terminals of the coil are connected to two slip rings. Carbon brushes are attached to slip rings so as to make connection with an external circuit.
Underlying principle of an A.C. generator
The underlying principle responsible for the working of an A.C. generator is electromagnetic induction. According to this principle, if a conductor is placed in a varying magnetic field, then current is induced in the conductor.
Generation of an alternating e.m.f. by a loop of wire rotating in a magnetic field
Correct diagram

Expression of the instantaneous value of the induced e.m.f. in a rotating loop
$\varepsilon = NBA\omega \sin\omega t$
Where N = number of turns in armature coil
B = Magnetic field vector
A =Area vector of the coil
ω = Angular speed

47.

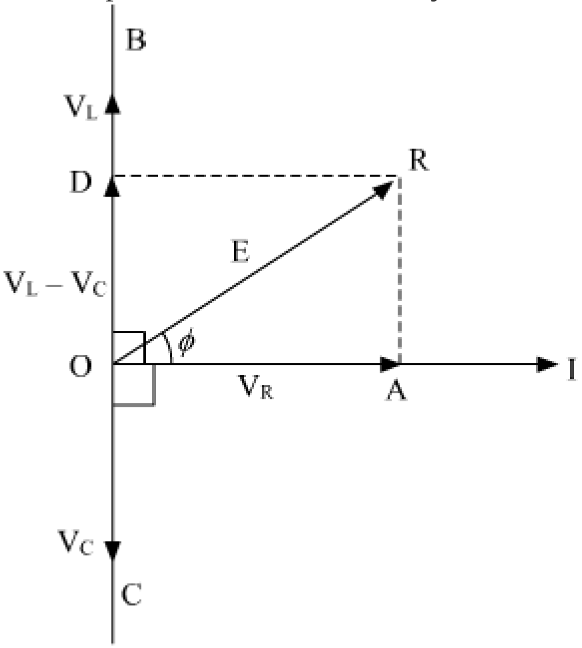
Let an alternating Emf $v = v_m \sin \omega t$ is applied to a series combination of inductor L, capacitor C and resistance R. Since all three of them are connected in series the current through them is same. But the voltage across each element has a different phase relation with current.



LCR Circuit

The potential difference V_L, V_C and V_R across L, C and R at any instant is given by
$V_L = IX_L$, $V_C = IX_C$ and $V_R = I_R$
Where I is the current at that instant.

X_L is inductive reactance and
X_C is capacitive reactance.
V_R is in phase with I. V_L leads I by 90° and V_C lags behind I by 90°



In the phases diagram,
V_L and V_C are opposite to each other. If $V_L > V_C$ then resultant $(V_L - V_C)$ is represent by OD. OR represent the resultant of V_R and $(V_L - V_C)$. It is equal to the applied Emf E.

$$E^2 = V_R^2 + (V_L - V_C)^2$$

$$E^2 = I^2 + \left[R^2 + (X_L - X_C)^2\right]$$

$$\text{or } I = \frac{E}{\sqrt{R^2 + (X_2 - X_C)^2}}$$

The term $\sqrt{R^2 + (X_2 - X_C)^2}$ is called impedance Z of the LCR circuit.

$$Z = \sqrt{R^2 + (X_2 - X_C)^2} = \sqrt{R^2 + \left(L\omega - \frac{1}{c\omega}\right)^2}$$

Emf leads current by a phase angle □

$$\tan\phi = \frac{V_L - V_C}{R} = \frac{X_L - X_C}{R} = \frac{L\omega - \frac{1}{c\omega}}{R}$$

The condition for resonance to occur

$$i_m = \frac{v_m}{\sqrt{R^2 + (X_C - X_L)^2}}$$

For resonance to occur, the value of i_m has to be the maximum.
The value of i_m will be the maximum when

$$X_C = X_L$$

$$\frac{1}{\omega C} = \omega L$$

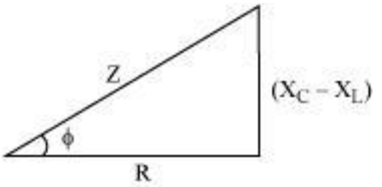
$$\omega^2 = \frac{1}{LC}$$

$$\omega = \frac{1}{\sqrt{LC}}$$

$$2\pi f = \frac{1}{\sqrt{LC}}$$

$$\boxed{f = \frac{1}{2\pi\sqrt{LC}}}$$

Power factor = cos Φ



$$\cos\phi = \frac{R}{Z} = \frac{R}{\sqrt{R^2 + (X_C - X_L)^2}}$$

Where,

(i) Conditions for maximum power factor (i.e., cos Φ = 1)

i. $X_C = X_L$

Or

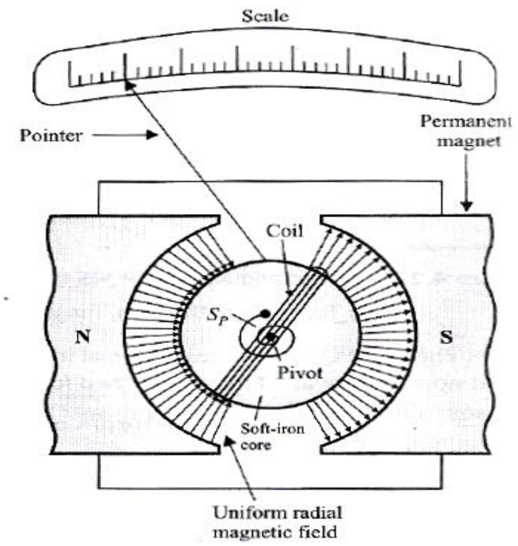
ii. $R = 0$

(ii) Conditions for minimum power factor

iii. When the circuit is purely inductive

iv. When the circuit is purely capacitive

48. A galvanometer is a device to detect current in a circuit, the magnitude of which depends on the strength of current.



Construction: A pivoted-type galvanometer consists of a rectangular coil of fine insulated copper wire wound on a light aluminium frame. The motion of the coil is controlled by a pair of hair springs of phosphor-bronze. The springs provide the restoring torque. A light aluminium pointer attached to the coil measures its deflection on a suitable scale.

The coil is placed symmetrically between the concave poles of a permanent horse-shoe magnet. There is a cylindrical soft iron core which not only makes the field radial but also increases the strength of the magnetic field.

Theory and working: As the field is radial, the plane of the coil always remains parallel to the field $\vec{B}$. When a current flows through the coil, a torque acts on it. It is

τ = Force x perpendicular distance = $NIbB$ x a sin 90 = $NIB(ab) = NIBA$

Here θ=90 , because the normal to the plane of coil remains perpendicular to the field $\vec{B}$ in all positions.

The torque τ deflects the coil through an angle α. A restoring torque is set up in the coil due to the elasticity of the springs such that

$$\tau_{restoring} = k\alpha$$

Where k is the torsion constant of the springs i.e., torque required to produce unit angular twist.

In equilibrium position,

Restoring torque = Deflecting torque

$k\alpha = NIBA$

$$\alpha = \frac{NBAI}{k}$$

Thus the deflection produced in the galvanometer coil is proportional to the current flowing through it.

Functions:

(i) A uniform magnetic field provides a linear current scale.

(ii) A soft iron core makes the field radial. It also increases the strength of the magnetic field and hence increases the sensitivity of the galvanometer.

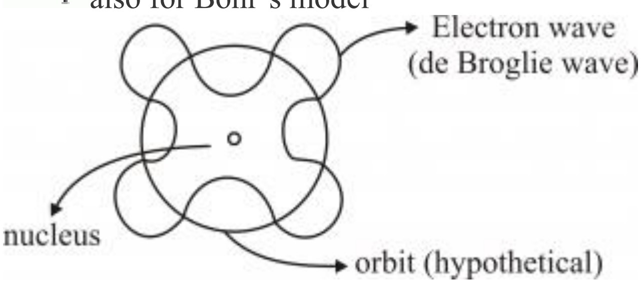
49. **(a) De Broglie's Explanation of Bohr's Second Postulate of Quantisation**

• De-Broglie's hypothesis that electron has a wavelength $\lambda = h/mv$ gave an explanation for Bohr's quantised orbits by bringing in the wave particle duality.

• Orbits correspond to circular standing waves in which the circumference of the orbits equal whole number of wavelength.

According to de Broglie's hypothesis

$\lambda = \frac{h}{p}$ also for Bohr's model



It states,

$$n\lambda = 2\pi r$$

$$\Rightarrow n\frac{h}{p} = 2\pi r$$

$$\Rightarrow rp = n\frac{h}{2\pi} \qquad (\text{as } rp = L)$$

$$\Rightarrow L = n\frac{h}{2\pi} \qquad \text{Bohr's II}^{\text{nd}} \text{ Postulate}$$

(b) Potential energy of electron in ground state of *H*-atom

$$V = -\frac{1}{4\pi \in_0}\cdot\frac{qq}{r_a} \qquad (r_a = \text{ Bohr's radius})$$

$$= -27.2\,\text{eV} \qquad (V = 2E_0)$$

Kinetic energy of electron in this state

$$K = \frac{1}{2}m_e v^2 \qquad v = \text{ Velocity of electron in ground state}$$

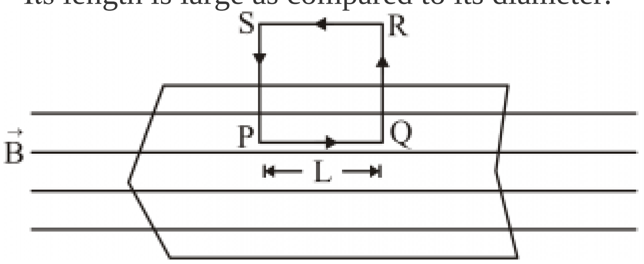
$$= 13.6\text{ eV}$$

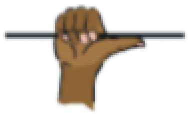
$$(K = E_0)$$

50. **(a) Solenoid**

• It consists of an insulating long wire closely wound in the form of helix.

• Its length is large as compared to its diameter.





• Magnetic field due to RQ and SP path is zero because they are perpendicular to the axis of solenoid. Since SR is outside the solenoid, the magnetic field is zero.

• The line integral of magnetic field induction $\vec{B}$ over the closed path PQRS is

$$\oint_{PQRS} \vec{B}\cdot\vec{dl} = \oint_{PQ} \vec{B}\cdot\vec{dl} = BL$$

From Ampere's circuital law,

$$\oint_{PQRS} \vec{B}\cdot\vec{dl} = \mu_0$$

× Total current through rectangle PQRS

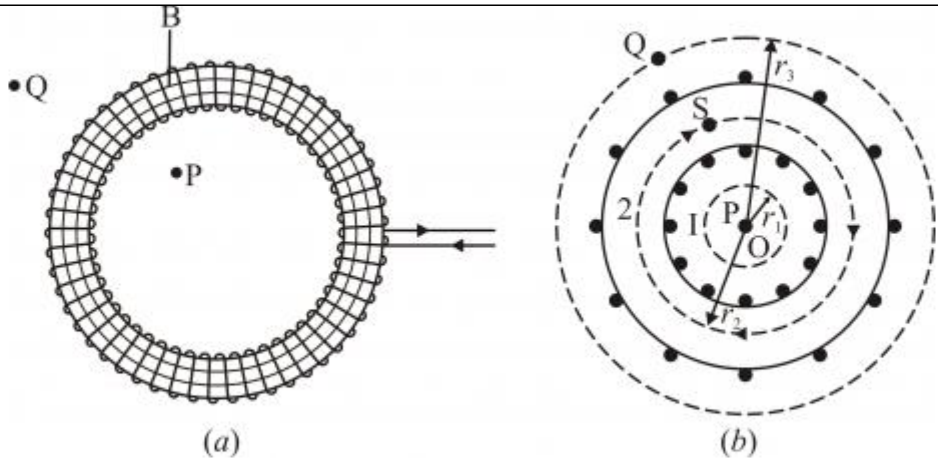
$B_L = \mu_0 \times$ Number of turns in rectangle × Current

$BL = \mu_0 nLI$

$\therefore B = \mu_0 nI$

(b) Toroid

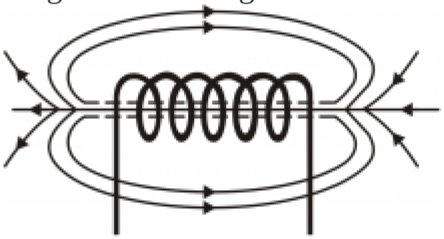
• It is a hollow circular ring on which a large number of turns of a wire are closely wound.



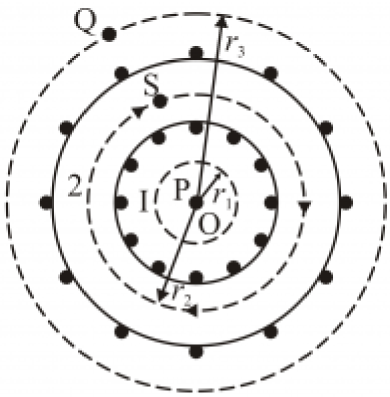
• Three Amperian loops (1, 2, and 3) are shown by dotted lines.
• Magnetic field along loop 1 is zero because the loop encloses no current.
• Magnetic field along loop 3 is zero because the current coming out of the paper is cancelled exactly by the current going out of it.
• Magnetic field at S (along loop 2):
From Ampere's law,
$\therefore B(2\pi r) = \mu_0 NI$
Where,
$B \rightarrow$ Magnetic field
$r \rightarrow$ Radius
$I \rightarrow$ Current
$N \rightarrow$ Number of turns of toroidal coil

$$\therefore B = \frac{\mu_0 NI}{2\pi r}$$

Magnetic field diagrams are as followed



Magnetic Field around a Solenoid



(b)

(c) The magnetic field lines inside a solenoid can be made strong by
(i) Inserting a ferromagnetic core
(ii) Increasing the number of turns of the solenoid.