CBSE Board
Class XII Physics – Set 1
Board Paper - 2007

Time: 3 hours **Total Marks: 70**

General instructions:

1. All questions are compulsory.
2. There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all three questions of five marks. You have to attempt only one of the choices in such questions.
3. Question numbers 1 to 5 are very short answer type questions, carrying one mark each.
4. Question numbers 6 to 12 are short answer type questions, carrying two marks each.
5. Question numbers 13 to 24 are also short answer type questions, carrying three marks each.
6. Question numbers 25 to 27 are long answers type questions, carrying five marks each.
7. Use of calculators in not permitted. However, you may use log tables if necessary.
8. You may use the following values of physical constants wherever necessary.
   $c = 3 \times 10^8\ ms^{-1}$
   $h = 6.626 \times 10^{-34}$ Js
   $e = 1.602 \times 10^{-19}$ C
   $\mu_o = 4\pi \times 10^{-7}\ TmA^{-1}$
   $\frac{1}{4\pi\varepsilon_o} = 9 \times 10^{-9}\ Nm^2C^{-2}$
   Mass of electron $m_e = 9.1 \times 10^{-31}$ kg
   Mass of neutron $m_n \cong 1.675 \times 10^{-27}$ kg
   Boltzmann's constant $k = 1.381 \times 10^{-23}\ J\ K^{-1}$
   Avogadro's number $N_A = 6.022 \times 10^{23}\ mol^{-1}$
   Radius of earth = 6400 km

1. An electron, an alpha particle and a proton have the same kinetic energy. Which one of these particles has the largest d-Broglie wavelength?

2. Why should the material used for making permanent magnets have high coercively?

3. The radioactive isotope D decays according to the sequence

$$D \xrightarrow{\beta^-} D_1 \xrightarrow{\alpha\text{-particle}} D_2$$

If the mass number and atomic number of D_2 are 176 and 71 respectively, what is (i) the mass number (ii) atomic number of D?

4. What will be the values of input A and B for the Boolean expression $\overline{(A+B)}.\overline{(A.B)}=1$?

5. Why is frequency modulation preferred over amplitude modulation for transmission of music?

6. The output of an OR gate is connected to both the inputs of a NAND gate. Draw the logic circuit of this combination of gates and write its truth table.

7. Draw a plot of potential energy of a pair of nucleons as a function of their separation. What is the significance of negative potential energy in the graph drawn?

8. A convex lens of refractive index 1.5 has a focal length of 18 cm in air. Calculate the change in its focal length when it is immersed in water of refractive index $\frac{4}{3}$.

9. Distinguish between the terms 'average value' and 'rms value' of an alternating current. The instantaneous current from an a.c. source is $I = 5\sin(314t)$ ampere. What are the average and rms values of the current?

10. Write the relation for the force $\vec{F}$ acting on a charge carrier q moving with a velocity $\vec{v}$ through a magnetic field $\vec{B}$ in vector notation. Using this relation, deduce the conditions under which this force will be (i) maximum (ii) minimum.

11. A cylindrical metallic wire is stretched to increase its length by 5%. Calculate the percentage change in its resistance.

12. The electric field E due to a point charge at any point near it is defined as $E = \lim_{q\to 0}\frac{F}{q}$, where q is the test charge and F is the force acting on it. What is the physical significance of $\lim_{q\to 0}$ in this expression? Draw the electric filed lines of a point charge Q when (i) $Q > 0$ and (ii) $Q < 0$.

OR

Define electric flux. Write its S.I. Units. A spherical rubber balloon carries a charge that is uniformity distributed over its surface. As the balloon is blown up and increases in size, how does the total electric flux coming out of the surface change? Give reason.

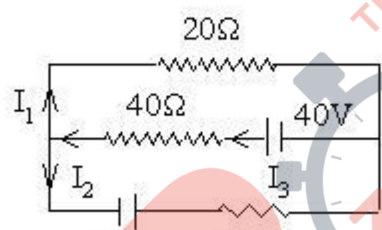
13. Deduce an expression for the electric potential due to an electric dipole at any point on its axis. Mention one contrasting feature of electric potential of a dipole at a point as compared to that due to single charge.

14. A parallel plate capacitor, each with plate area A and separation d, is charged to a potential difference V. The battery used to charge it is then disconnected. A dielectric slab of thickness d and dielectric constant K is now placed between the plates. What change, if any, will take place in

(i) charge on the plates
(ii) electric field intensity between the plates
(iii) capacitance of the capacitor

Justify your answer in each case.

15. State Kirchhoff's rules of current distribution in an electrical network. Using these rules determine the value of the current I_1 in the electric circuit given below.



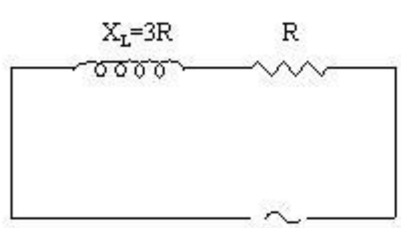
16. Write the mathematical relation for the resistivity of material in terms of relaxation time, number density and mass and charge of charge carriers in it. Explain, using this relation, why the resistivity of a metal increases and that of semi-conductor decreases with rise in temperature.

17. Explain with the help of a labelled diagram the underlying principle and working of a step- up transformer. Why cannot such a device be used to step – up d.c voltage?

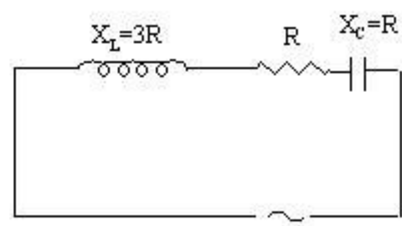
OR

Draw a labelled diagram of an a.c generator. Explain briefly its principle and working.

18. Given below are two electric circuits A and B



A



B

Calculate the ratio of power factor of the circuit B to the power factor of circuit A.

19. Define the term 'resolving power' of an astronomical telescope. How does it get affected on

(i) increasing the aperture of the objective lens?

(ii) increasing the wavelength of the light used?

Justify your answer in each case.

20. Write any four characteristics of electromagnetic waves. Give two uses each of (i) radio-waves (ii) micro-waves.

21. In a plot of photoelectric current versus anode potential, how does

(i) the saturation current vary with anode potential for incident radiations of different frequencies but same intensity?

(ii) the stopping potential vary for incident radiations of different intensities but same frequency?

(iii) Photoelectric current vary for different intensities but same frequency of incident radiations?

Justify your answer in each case.

22. Calculate the amount of energy released during the α decay of ${}^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He$

Given:

1. Atomic mass of ${}^{238}_{92}U = 238.05079u$

2. Atomic mass of ${}^{234}_{90}Th = 234.04363u$

3. Atomic mass of ${}^{4}_{2}He = 4.00260u$

$$1u = 931.5 MeV/c^2.$$

Is this decay spontaneous? Give reason.

23. What is a digital signal? Write two advantages of digital communication. Give any one difference between Fax and E-mail systems of communication.

24. Explain, with the help of a schematic diagram, the principle and working of a Light Emitting Diode. What criterion is kept in mind while choosing the semiconductor material for such a device? Write any two advantages of Light Emitting Diode over conventional indcandescent lamps.

25. Draw a labelled diagram of a moving coil galvanometer. State the principle on which it works.

Deduce an expression for the torque acting on a rectangular current carrying loop kept in a uniform magnetic field. Write two factors on which the current sensitivity of a moving coil galvanometer depends.

OR

State Biot-Savart law. Use it to derive an expression for the magnetic field at the centre of a circular loop of radius R carrying a steady current I. Sketch the magnetic field lines for such a current carrying loop.

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

OR

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

(i) first minimum at an angle of diffraction of 30^o.
(ii) first maximum at an angle of diffraction of 30^o.

27. State the principle of working of p-n diode as a rectifier. Explain, with the help of a circuit diagram, the use of p-n diode as a full wave rectifier. Draw a sketch of the input and output waveforms.

OR

Draw the symbolic representation of a (i) p- n- p, (ii) n- p- n transistor. Why is the base region of transistor thin and lightly doped? With proper circuit diagram, show the biasing of a p- n- p transistor in common base configuration. Explain the movement of charge carriers through different parts of the transistor in such a configuration and show that $I_E = I_C + I_B$.

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1. Electron has the largest d-Broglie wavelength, because

$$\lambda = \frac{h}{\sqrt{2mK}} \text{ i.e., } \lambda \propto \frac{1}{\sqrt{m}}$$

2. High coercively ensures that the magnetization is not destroyed by stray magnetic fields or temperature variations.

3. We can represent the decay as follows:

$$ {}^{180}_{72}D \xrightarrow{{}^{0}_{-1}e} {}^{180}_{73}D_1 \xrightarrow{{}^{4}_{2}He} {}^{176}_{71}D_2 $$

(i) Mass number of $D = 180$
(ii) Atomic number of $D = 72$

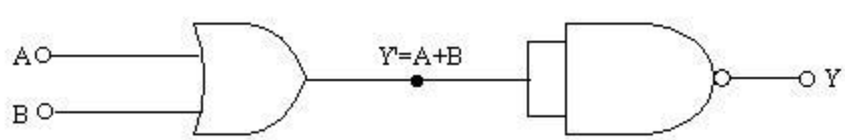
4. The truth table for the Boolean Expression $\overline{(A+B)}.\overline{(A.B)}$ is

A	B	(A+B)	(A.B)	$\overline{(A+B)}$	$\overline{(A.B)}$	$\overline{(A+B)}.\overline{(A.B)}$
0	0	0	0	1	1	1
0	1	1	0	0	1	0
1	0	1	0	0	1	0
1	1	1	1	0	0	0

The above Boolean expression will be 1 only when A=0 and B=0.

5. F.M. transmission gives higher fidelity reception than A.M. transmission due to the presence of a large number of sidebands.

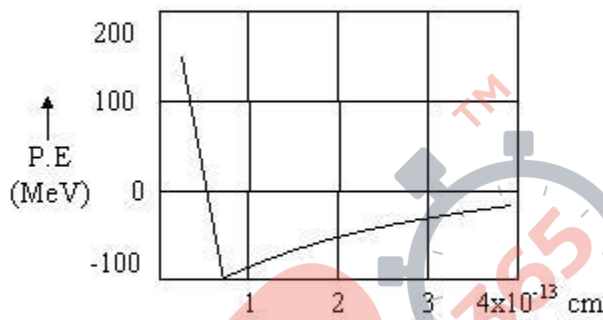
6. The logic circuit is shown below.



Truth Table

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

7. A plot of potential energy of a pair of nucleolus as a function of their separation is shown below.



The negative potential energy indicates the force of attraction between the pair of nucleons.

8. For the lens in air,

$$\frac{1}{f_a} = \left({}^a\mu_g - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right] \text{or } \frac{1}{18} = (1.5-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

$$\text{or } \frac{1}{R_1} - \frac{1}{R_2} = \frac{1}{9}$$

When the lens is immersed in water

$$\frac{1}{fw} = \left(\frac{\mu_g}{\mu_w} - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right] = \left(\frac{1.5}{4/3} - 1\right) \times \frac{1}{9}$$

$$\text{or } \frac{1}{fw} = \frac{1}{8} \times \frac{1}{9} = \frac{1}{72}$$

$$\text{or } f_w = 72\text{cm}$$

Change in focal length = 72 - 18 = 54 cm.

9. Average value of a.c. is that value of a direct current which sends the same charge in a circuit in the same time as is sent by the given alternating current in its halftime period.

$$I_{av} = \frac{2}{\pi} I_0$$

rms value of a.c. is that value of a direct current which produces the same heating effect in a given resistor as is produced by the given alternating current when passed for the same time.

$$I_{rms} = \frac{1}{\sqrt{2}} I_0.$$

Given $I = 5\sin(314t)$ ampere

$\therefore$ Peak value of current, $I_0 = 5A$

$$I_{av} = 0.637 I_0 = 0.637 \times 5 = 3.185\,A$$

$$I_{rms} = 0.707 I_0 = 0.707 \times 5 = 3.535 A.$$

10. $\vec{F} = q\left(\vec{v} \times \vec{B}\right)$

or $F = q v B \sin\theta$

(i) When $\theta = 90°, F = qv\sin 90 = qv$ i.e., force is maximum.

(ii) When $\theta = 0°, F = qvB\sin 0° = 0$ *i.e.* force is minimum.

11. New length is

$$l' = l + 5\% \text{ of } l = 1.05l$$

Volume remains constant, so $Al = A'l'$

$$\therefore \frac{A}{A'} = \frac{l'}{l} = 1.05$$

$$\frac{R'}{R} = \frac{l'}{l} \times \frac{A}{A'} = \left(\frac{l'}{l}\right)^2 = (1.05)^2 = 1.1025$$

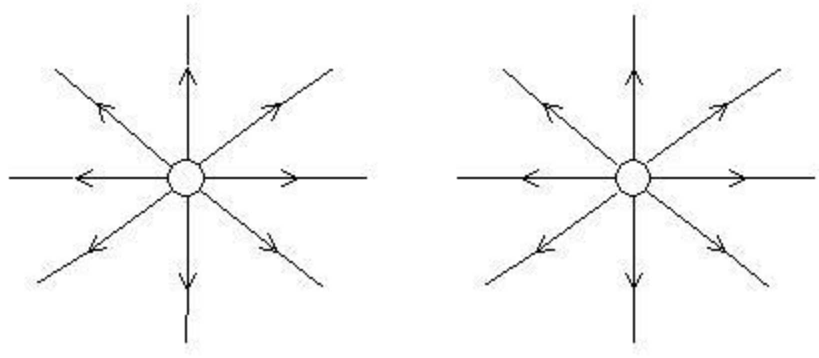
Percentage increase in resistance is

$$\frac{R' - R}{R} \times 100 = \left(\frac{R'}{R} - 1\right) \times 100 = (1.1025 - 1) \times 100$$

$$= 10.25\%$$

12. The $\lim\limits_{q \to 0}$ indicates that the test charge q is so small that its presence does not disturb the distribution of source charge and hence its electric field.

The electric fields of the point charge Q are shown below.



OR

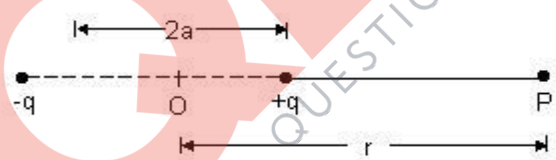
The electric flux through a given surface area is the total number of electric lines of force passing normally through that area. It is given by.

$\phi E = \vec{E} \cdot \vec{\Delta S}$

SI unit of electric flux is $Nm^2 - C^{-1}$

As the balloon is blown up, the total charge on the balloon surface remains unchanged, so the total electric flux coming out of its surface remains unchanged.

13. Let P be an axial point at distance r from the centre of the dipole.



Electric potential at point P will be

$$V = V_1 + V_2 = -\frac{1}{4\pi\varepsilon_0}\frac{q}{r+a} + \frac{1}{4\pi\varepsilon_0}\frac{q}{r-a}$$

$$= \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{r-a} - \frac{1}{r+a}\right] = \frac{q}{4\pi\varepsilon_0}\cdot\frac{2a}{r^2-a^2}$$

$$= \frac{1}{4\pi\varepsilon_0}\cdot\frac{p}{r^2-a^2} \qquad [q \times 2a = p]$$

For a far away point, $r >> a$

$$\therefore \qquad V = \frac{1}{4\pi\varepsilon_0}\frac{p}{r^2}$$

At large distances, dipole potential falls off as $1/r^2$, whereas the potential due to a single charge falls off as $1/r$.

14.

(i) The charge q on the capacitor plates remains same.

(ii) The electric field intensity between the capacitor plates decreases due to the introduction of a dielectric. Introduction of dielectric field creates an intrinsic electric field directed opposite to the original electric field. That is why the electric field intensity decreases.

(iii) The capacitance of the capacitor increases due to the introduction of a dielectric. Electric field decreases, therefore, the capacitor can get more charge to bring back the electric field to its original value. This increases the capacity of holding the charge and hence the capacitance increases.

15. Kirchhoff's rules for electrical networks are as follows:-

(i) **Junction rule:** At any junction, the sum of the currents entering the junction is equal to the sum of currents leaving the junction.

(ii) **Loop rule:** The algebraic sum of the changes in potential around any closed loop involving resistors and cells in the loop is zero.

Numerical: By Kirchoff's rule, $I_1 + I_2 = I_3$

Applying loop rule to both the lower and upper loops, we get $40\,I_3 + 20\,I_1 = 40$

$$40 I_3 + 20 I_2 = 80 + 40$$

Adding the two equations, we get

$$80 I_3 + 20(I_1 + I_2) = 160$$

Or $80 I_3 + 20\,I_3 = 160$

Or $I_3 = \frac{160}{100} = 1.6A$

Again, $40 \times 1.6 + 20 I_1 = 40$

Or $20 I_1 = 40 - 64 = -24$

Or $I_1 = -\frac{24}{20} = -1.2A$

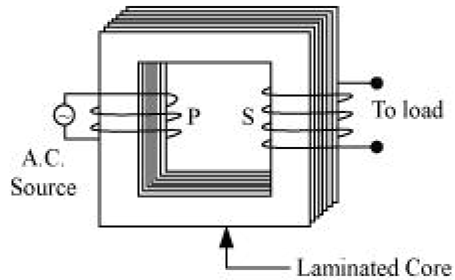
16. Resistivity, $\rho = \frac{m}{ne^2\tau}$

(i) **Metals:** As the temperature increases, the thermal speed of electrons increases. Free electrons collide more frequently with the positive metal ions. The relaxation time decreases. Consequently, the resistivity ρ of the metal increases.

(ii) **Semiconductors:** The relaxation time τ does not change with the temperature. But the number density (n) of free electrons increases exponentially with temperature. As result, the sensitivity of semiconductor decreases exponentially with the increase in temperature.

17. Transformer:

Principle: It is a device which converts high voltage AC into low voltage AC and vice-versa. It is based upon the principle of mutual induction. When alternating current is passed through a coil, an induced emf is set up in the neighbouring coil.



Working: When an alternating current is passed through the primary, the magnetic flux through the iron core changes, which does two things. It produces emf in the primary and an induced emf is also set up in the secondary. If we assume that the resistance of primary is negligible, then the back emf will be equal to the voltage applied to the primary.

$$\therefore V_1 = -N_1 \frac{d\phi}{dt}$$

$$\text{and } V_2 = -N_2 \frac{d\phi}{dt}$$

Where, N_1 and N_2 are number of turns in the primary and the secondary respectively and V_1 and V_2 are their voltages respectively.

$$\therefore \frac{V_2}{V_1} = \frac{N_1}{N_2}$$

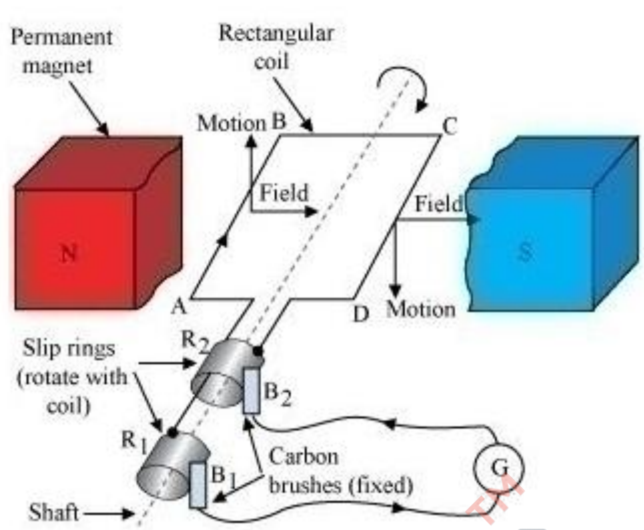
In a step-up transformer: $N_2 > N_1$, therefore, $V_2 > V_1$

Such a device cannot be used to step up a dc because a dc voltage cannot produce a changing flux, which is very essential to the production of induced emf in the secondary.

OR

AC Generator:

Principle: It works on the principle of Faraday's law of electromagnetic induction. Whenever a coil is rotated in a uniform magnetic field about an axis perpendicular to the field, the magnetic flux linked with coil changes and an induced emf is set up across its ends.



The essential parts of an ac generator are shown in the figure. Initially, the armature coil ABCD is horizontal. As the coil is rotated clockwise, the arm AB moves up and CD moves down.

The magnetic flux linked with the coil at any instant is:

$$\phi = NBA\cos\omega t$$

Induced emf will be

$$E = -\frac{d\phi}{dt} = -\frac{d}{dt}(NBA\cos\omega t) = NBA\omega\sin\omega t$$

Let E_0 be the peak value of induced emf.

$$E = E_0 \sin \omega t$$

where, $E_0 = NBA\omega$

18. Power factor of $A = \frac{R}{Z} = \frac{R}{\sqrt{R^2 + X_L^2}} = \frac{R}{\sqrt{R^2 + 9R^2}} = \frac{R}{\sqrt{10}R} = \frac{1}{\sqrt{10}}$

$$\text{Power factor of B} = \frac{R}{\sqrt{R^2 + (X_L - X_C)^2}} = \frac{R}{\sqrt{R^2 + (3R - R)^2}} = \frac{1}{\sqrt{5}}$$

$$\frac{\text{Power factor of B}}{\text{Power factor of A}} = \frac{1}{\sqrt{5}} \times \frac{\sqrt{10}}{1} = \sqrt{2}$$

19. The resolving power of an astronomical telescope is defined as the reciprocal of the smallest angular separation between two point objects whose images can just be resolved by the telescope.

$$\text{R.P.} = \frac{D}{1.22\lambda}$$

(i) When the aperture of the objective lens is increased, the resolving power increases, because $\text{R.P.} \propto D$.

(ii) When the wavelength of the light is increased, the resolving power decreases, because $R.P. \propto l/\lambda$.

20. Characteristic of electromagnetic waves are as follows: -

(i) They do not require any material medium for their propagation.

(ii) The oscillations of $\vec{E}$ and $\vec{B}$ are perpendicular to each other and are in same phase.

(iii) They are transverse in nature.

(iv) They travel through vacuum with same speed, $c = 3\times10^{8}ms^{-1}$

(i) **Radiowaves are used**

(a) in radiotransmission

(b) in radioastronomy.

(ii) **Microwaves are used**

(a) in microwave-ovens

(b) in radar systems.

21.

(i) Saturation current is same for incident radiations of different frequencies but of same intensity. It does not change with increase in anode potential.

(ii) Stopping potential is same for incident radiation of different intensities but same frequency. This is because stopping potential depends on frequency and not on the intensity of incident radiation.

(iii) Photoelectric current increases linearly with the intensity of incident radiation of same frequency.

22. The energy released in the α decay is

$$Q = \left[m\left({}^{238}_{92}U\right) - m\left({}^{238}_{92}Th\right) - m\left({}^{4}_{2}He\right)\right]c^2$$

$$= [238.05079 - 234.04363 - 4.00260]\times931.5MeV$$

$$= 0.00456\times931.5 = 4.25MeV$$

As the Q - value is positive, the decay process is spontaneous.

23. A digital signal is that in which current or voltage takes only two discrete values.

Advantages of digital communication are as follows:

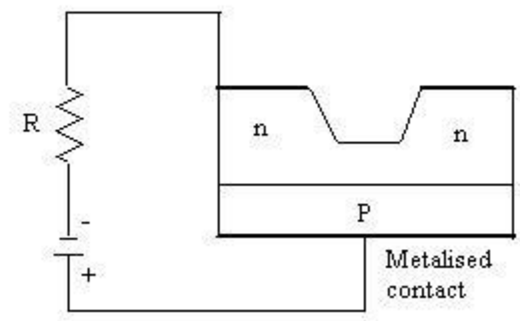
(i) This mode of communication is more reliable.

(ii) Its transmission needs simple technique.

In Fax, we get a hard copy of the message at the recipient's terminal.

In E-mail, we get a soft copy of the message at the recipient's terminal.

24. A light emitting diode is simply a forward biased p-n junction, which emits light when energised.



In a forward biased p -n junction, the electrons of the n- region and holes of p -region are pushed towards the junction where electron hole recombination taken place. As the electrons are in higher conduction band on n-side and holes are in lower valence band on p -side, the energy difference appears in the form of heat or light radiation during the process of recombination.

The semiconductor used in LED is chosen according to the wavelength of the emitted light.

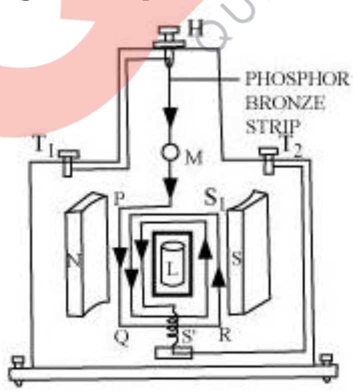
Advantages of LED over conventional incandescent lamps are as follows:

(i) Low operational voltage and less power consumption

(ii) Fast action and no warm up time required.

25. Moving coil galvanometer

Principle: A current carrying coil suspended in a magnetic field experiences a torque.

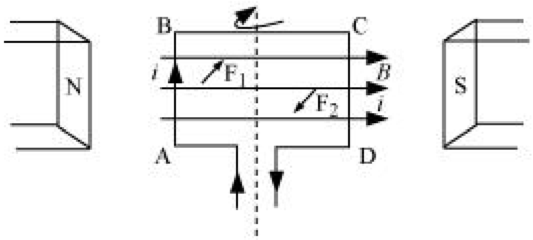


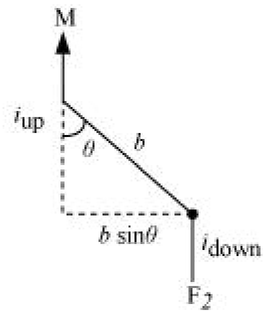
Let I be the current through the loop PQRS.

a, b = Sides of the rectangular loop

A = ab = Area of the loop

N = Number of turns in the loop





According to Fleming's left hand rule, the side AB experiences a normal inward force, $F_1 = IaB$ and side CD experiences a normal outward force, $F_2 = IaB$. These two equal and opposite forces form a couple, which exerts a torque given by,

τ = Force × Perpendicular distance

$= IaB \times b \sin\theta$

$= IBab \sin\theta$

$\tau = IBA \sin\theta$

For N turns,

$\tau = NIBA \sin\theta$

The current sensitivity of a moving coil galvanometer depends on

(i) number of turns in the galvanometer coil

(ii) torsional constant of the suspension fibre.

OR

Biot-Savart law states that the magnetic field dB due to the current element dl at any point P is

(i) directly proportional to the current I, $dB \propto I$

(ii) directly proportional to the length dl of the element, $dB \propto dl$

(iii) directly proportional to $\sin\theta$, where θ is the angle between dl and r, $dB \propto \sin\theta$

(iv) inversely proportional to the square of the distance r from the current element AB, $dB \propto \frac{1}{r^2}$

From (i), (ii), (iii), and (iv), we obtain

$$dB \propto \frac{Idl\sin\theta}{r^2}$$

$$dB = \frac{\mu_o}{4\pi}\frac{Idl\sin\theta}{r^2}$$

$$\theta = 90^\circ$$

$$dB = \frac{\mu_o}{4\pi}\frac{Idl}{(x^2+R^2)}$$

$$\cos\theta = \frac{R}{(x^2+R^2)^{1/2}}$$

$$dB_x = dB\cos\theta$$

$$= \frac{\mu_o}{4\pi}\frac{Idl}{(x^2+R^2)} \times \frac{R}{(x^2+R^2)^{1/2}}$$

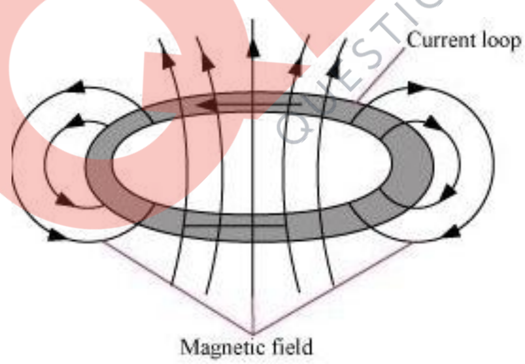
$$= \frac{\mu_o}{4\pi}\frac{IRdl}{(x^2+R^2)^{3/2}}$$

$$B = \int_0^{2\pi} dB_x = \int_0^{2\pi}\frac{\mu_o}{4\pi}\frac{IRdl}{(x^2+R^2)^{3/2}} = \frac{\mu_o}{4\pi}\frac{IR}{(x^2+R^2)^{3/2}}\int_0^{2\pi} dl = \frac{\mu_o}{4\pi}\frac{IR}{(x^2+R^2)^{3/2}} \times 2\pi R$$

$$= \frac{\mu_o}{2}\frac{IR^2}{(x^2+R^2)^{3/2}}$$

At centre, x = 0

$$B = \frac{\mu_o}{2}\frac{I}{R}$$



26. Two sources of light which continuously emit light waves of same frequency with a zero or constant phase difference between them are called coherent sources. Coherent sources are necessary to produce sustained interference pattern. Otherwise the phase difference between the two interfering waves will change rapidly and the interference pattern will be lost.
Example: A thin film of oil spread over water shows beautiful colours due to interference of light.

Numerical: Distance of the fourth bright fringe from the central bright fringe is

$$x_4 = \frac{4D\lambda}{d}$$

$$\therefore \lambda = \frac{dx_4}{4D} = \frac{0.03\times10^{-2}\times1\times10^{-2}}{4\times1.5} = 5\times10^{-7}\text{ m.}$$

Or

Diffraction of light takes place when the width of the slit is comparable to the wavelength of light used.

Let x_n be the distance of the n^{th} minimum from the centre of the screen and D be the distance between the slit and the screen. Then, x_n is given by:

$$x_n = \frac{nD\lambda}{a}$$

The first minimum, therefore, occurs at $x_1 = \frac{D\lambda}{a}$

The central maximum extends up to this distance x_1 (distance of the first secondary minimum from the centre).

The width of the central maximum will, therefore, be $2x_1$.

Hence, the width of central maximum will be $2x_1 = \frac{2D\lambda}{a}$

Numerical :

(i) Condition for first minimum is

$a \sin\theta = \lambda$

$$a = \frac{\lambda}{\sin\theta} = \frac{700\text{nm}}{\sin30^\circ} = \frac{700\text{nm}}{0.5}$$

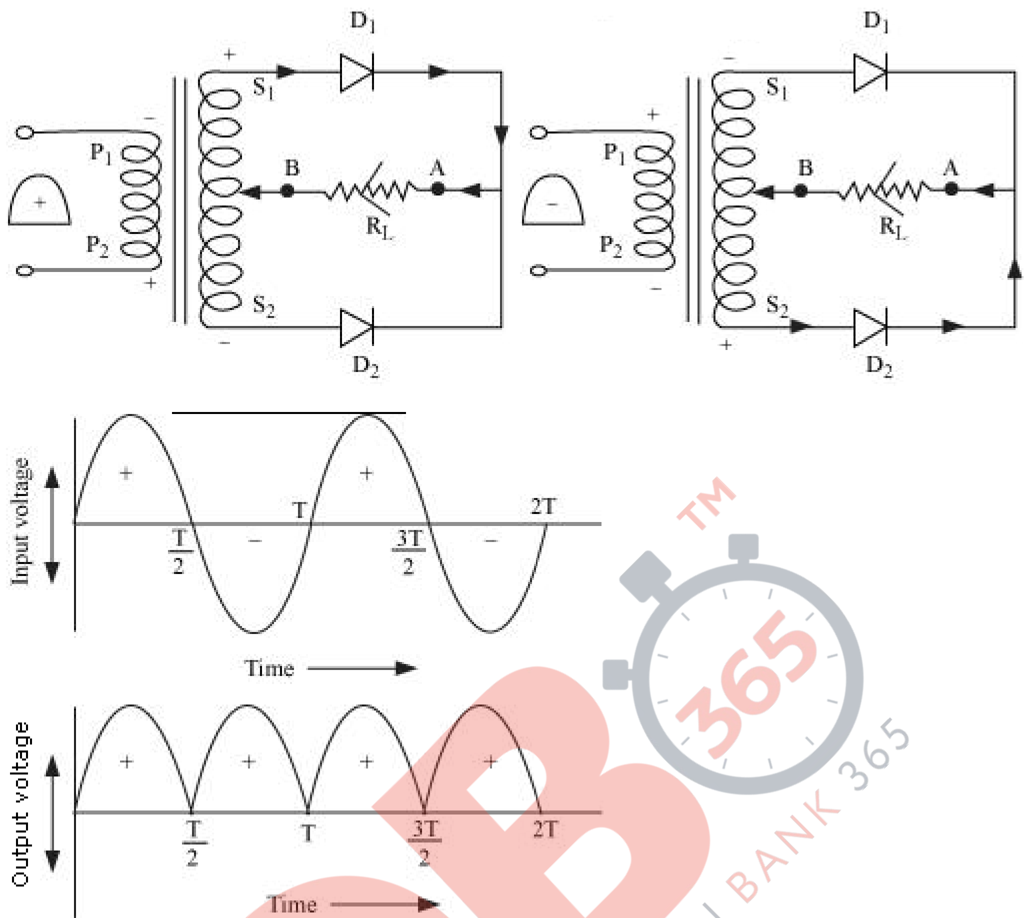
$$= 1400\text{nm}$$

(ii) Condition for first maximum is

$$a\sin\theta = \frac{3\lambda}{2}$$

$$a = \frac{3\lambda}{2\sin\theta} = \frac{3\times700\text{nm}}{2\times\sin30^\circ} = 2100\text{ nm}$$

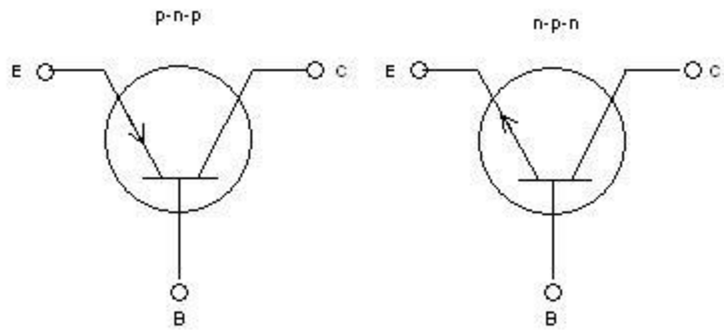
27. Principle: A junction diode offers a low resistance to current in one direction and a high resistance in the other direction. Thus, the diode acts as a rectifier.



Full wave rectifier:
When the diode rectifies the whole of the AC wave, it is called full wave rectifier.
The figure shows the arrangement for using diode as full wave rectifier. The alternating input signal is fed to the primary P_1P_2 of a transformer. The output signal appears across the load resistance R_L.
During the positive half of the input signal, suppose P_1 and P_2 are negative and positive respectively. This would mean that S_1 and S_2 are positive and negative respectively. Therefore, the diode D_1 is forward biased and D_2 is reverse biased. The flow of current in the load resistance R_L is from A to B.
During the negative half of the input signal, S_1 and S_2 are negative and positive respectively. Therefore, the diode D_1 is reverse biased and D_2 is forward biased. The flow of current in the load resistance R_L is from A to B.

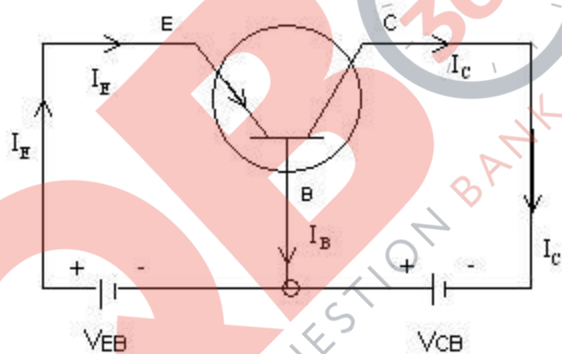
OR

The symbols of p-n -p and n- p -n transistors are given below.



The base region is made thin and lightly doped so that it contains very few majority charge carriers. This reduces the recombination rate of electrons and holes across the emitter-base junction. This increases collector current and hence increases current gain of the transistor.

Action of p- n- p transistor: The emitter base junction is forward biased by battery V_{EB} and collector-base junction is reverse biased by battery V_{CB}.



The positive terminal of the battery V_{EB} repels the holes of the emitter towards the base. About 5% of the holes recombine with the electrons of the base. The remaining 95% of the holes enter the collector region. As the holes reach the end of the collector region, they attract the electrons from the negative terminal of the battery V_{CB} and combine with them. At the same time covalent bonds are broken in the emitter region, and an equal number of electrons get attracted towards the positive terminal of V_{EB} and holes flow towards the base. Hence $I_E = I_B + I_C$