

# Solved Paper 2013

## Physics

### Class-XII

Time : 3 Hours

Max. Marks : 70

#### General Instructions :

- (i) All questions are compulsory.
- (ii) There are 29 questions in total. Questions 1 to 8 are very short answer type questions and carry one mark each.
- (iii) Questions 9 to 16 carry two marks each, questions 17 to 25 carry three marks each and questions 27 to 29 carry five marks each.
- (iv) 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 each. You have to attempt only one of the choices in such questions.
- (v) Question 26 is a value based question carrying four marks.
- (vi) Use of calculators is **not** permitted. However, you may use log tables if necessary.
- (vii) You may use the following values of physical constants wherever necessary :

$$\begin{aligned}
 c &= 3 \times 10^8 \text{ m/s} \\
 h &= 6.63 \times 10^{-34} \text{ Js} \\
 e &= 1.6 \times 10^{-19} \text{ C} \\
 \mu_0 &= 4\pi \times 10^{-7} \text{ T m A}^{-1} \\
 \frac{1}{4\pi\epsilon_0} &= 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2} \\
 m_e &= 9.1 \times 10^{-31} \text{ kg} \\
 \text{Mass of Neutron} &= 1.675 \times 10^{-27} \text{ kg} \\
 \text{Mass of Proton} &= 1.673 \times 10^{-27} \text{ kg}
 \end{aligned}$$

1. Write the expression for the work done on an electric dipole of dipole moment  $\vec{p}$  in turning it

from its position of stable equilibrium to a position of unstable equilibrium in a uniform electric field  $\vec{E}$ .

Ans. In stable equilibrium the angle between  $\vec{P}$  and  $\vec{E}$  is  $0^\circ$

In unstable equilibrium the angle between  $\vec{P}$  and  $\vec{E}$  is  $180^\circ$

$$\begin{aligned}
 \text{So, the work done} &= PE(\cos \theta_1 - \cos \theta_2) \\
 &= PE(\cos 0^\circ - \cos 180^\circ) \\
 &= PE(1+1) \\
 &= 2PE
 \end{aligned}$$

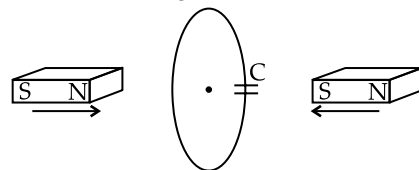
2. Is the steady electric current the only source of magnetic field? Justify your answer.

Ans. No. Displacement current, alternating current, electromagnet, permanent magnet can also produce magnetic field.

3. When is  $H_\alpha$  line of the Balmer series in the emission spectrum of hydrogen atom obtained?

Ans.  $H_\alpha$  line in emission spectrum of Hydrogen atom is obtained when electron falls from its third ( $n = 3$ ) to second lowest ( $n = 2$ ) energy level.

4. Predict the polarity of the capacitor in the situation described in the figure.



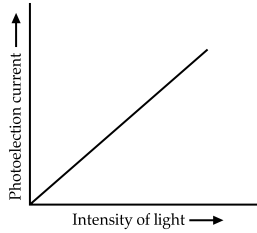
Ans. Looking from left side the current will be anticlockwise. Looking from right side the current will be clockwise. So, upper plate will be positive and lower plate will be negative.

5. Why is the core of a transformer laminated?

Ans. Core of a transformer is laminated to reduce the eddy current.

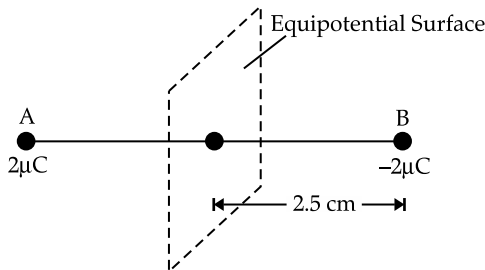
6. Show on a plot the nature of variation of photoelectric current with the intensity of radiation incident on a photosensitive surface.

Ans. Photoelectric current is proportional to intensity of light. So, the graph will be a straight line passing through the origin.



- \* 7. Where on the surface of Earth is the vertical component of Earth's magnetic field zero?  
 8. Two charges  $2\ \mu\text{C}$  and  $-2\ \mu\text{C}$  are placed at points A and B 5 cm apart. Depict an equipotential surface of the system.

Ans.



9. Write a relation between current and drift velocity of electrons in a conductor. Use this relation to explain how the resistance of a conductor changes with the rise in temperature.

Ans. The relation between current and drift velocity of electron is

$$I = neAv_d$$

$n$  = number density of electrons  
 $A$  = cross-sectional area  
 $e$  = charge of electron  
 $I$  = current

$$v_d = \frac{eE}{ml}\tau$$

$E$  = potential difference across the conductor  
 $\tau$  = Relaxation time  
 $l$  = length of the conductor

$$\therefore I = neA \times \frac{eV}{ml}\tau$$

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

As the temperature increases, the number of collisions increases and  $\tau$  decreases and hence the resistance increases.

10. A coil of 'N' turns and radius 'R' carries a current 'I'. It is unwound and rewound to make a square coil of side 'a' having same number of turns (N). Keeping the current 'I' same, find the ratio of the magnetic moments of the square coil and the circular coil.

Ans. Magnetic moment =  $M = NIA$

$$M_{\text{circular}} = NI\pi R^2$$

After rewinding,  $2\pi R = 4a$

$$\therefore a = \frac{\pi R}{2}$$

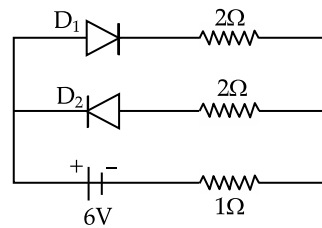
$$M_{\text{square}} = NIa^2$$

$$\text{Or, } M_{\text{square}} = NI\left(\frac{\pi R}{2}\right)^2$$

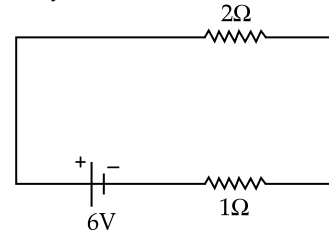
$$\therefore M_{\text{square}} = \frac{NI\pi^2 R^2}{4}$$

$$\text{Now, } \frac{M_{\text{square}}}{M_{\text{circular}}} = \frac{\pi}{4}$$

11. Assuming that the two diodes  $D_1$  and  $D_2$  used in the electric circuit shown in the figure are ideal, find out the value of the current flowing through  $1\ \Omega$  resistor.



Ans.  $D_1$  is forward biased.  $D_2$  is reversed biased. Hence, the circuit may be considered as:



So, the current through  $1\ \Omega$  resistor is

$$\frac{6V}{(2+1)\Omega} = 2A$$

12. In the ground state of hydrogen atom, its Bohr radius is given as  $5.3 \times 10^{-11}\ \text{m}$ . The atom is excited such that the radius becomes  $21.2 \times 10^{-11}\ \text{m}$ . Find (i) the value of the principal quantum number and (ii) the total energy of the atom in this excited state.

Ans. (i)  $r = r_0 n^2$   
 or,  $21.2 \times 10^{-11} = 5.3 \times 10^{-11} \times n^2$   
 or,  $4 = n^2$   
 $\therefore n = 2$

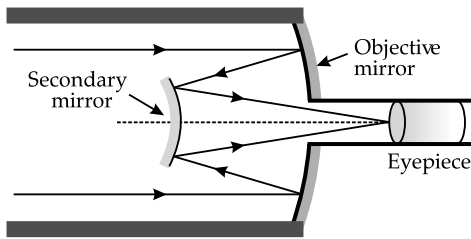
(ii)  $E = -\frac{13.6eV}{n^2}$

Or,  $E = -\frac{13.6eV}{4}$

$$\therefore E = -3.4eV$$

13. Draw a schematic arrangement of a reflecting telescope (Cassegrain) showing how rays coming from a distant object are received at the eye-piece. Write its two important advantages over a refracting telescope.

Ans. Reflecting telescope



Advantages:

- (a) Image is brighter.
- (b) Free from chromatic aberration.

\* 14. A message signal of frequency 10 kHz and peak voltage 10 V is used to modulate a carrier of frequency 1 MHz and peak voltage 20 V. Determine

- (i) the modulation index,
- (ii) the side bands produced.

15. (a) How are electromagnetic waves produced?

(b) How do you convince yourself that electromagnetic waves carry energy and momentum ?

OR

(a) Arrange the following electromagnetic waves in the descending order of their wavelengths:

- (i) Microwaves
- (ii) Infra-red rays
- (iii) Ultra-violet radiation
- (iv) Gamma rays

(b) Write one use each of any two of them.

Ans. (a) Accelerating electric charge produces electromagnetic waves.

(b) When electromagnetic wave of suitable frequency on incident on photoelectrons come out. So, electromagnetic waves must have energy and momentum so that it can kick off photoelectrons from its shell. Thus I am convinced.

OR

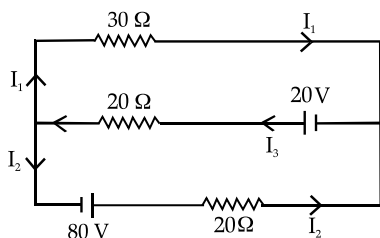
(a) Arranged in descending order:

Microwave, Infrared, Ultraviolet, Gamma-rays

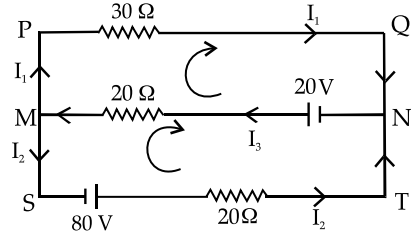
(b) Use of microwave: Used in RADAR system.

Use of Infrared: Used in night-photography.

16. Use Kirchoff's rules to determine the value of the current  $I_1$  flowing in the circuit shown in the figure.



Ans. The given circuit:



At node M, applying KCL,

$$I_3 = I_1 + I_2$$

In loop MPQN, applying KVL,

$$20I_3 + 30I_1 = 20$$

$$\text{Or, } 20(I_1 + I_2) + 30I_1 = 20$$

$$\text{Or, } 50I_1 + 20I_2 = 20$$

$$\text{Or, } 5I_1 + 2I_2 = 2 \quad \dots(i)$$

In loop MSTN, applying KVL,

$$-20I_2 - 20I_3 = -20 - 80 = -100$$

$$\text{Or, } -20I_2 - 20(I_1 + I_2) = -100$$

$$\text{Or, } -20I_1 - 40I_2 = -100$$

$$\text{Or, } -I_1 - 2I_2 = -5 \quad \dots(ii)$$

Solving equations (i) and (ii)

$$I_1 = -\frac{3}{4} A$$

\* 17. Draw a labelled schematic diagram of a Van-de-Graaff generator. State its working principle. Describe briefly how it is used to generate high voltages.

18. Starting from the expression for the energy

$$W = \frac{1}{2} LI^2, \text{ stored in a solenoid of self-inductance}$$

$L$  to build up the current  $I$ , obtain the expression for the magnetic energy in terms of the magnetic field  $B$ , area  $A$  and length  $l$  of the solenoid having  $n$  number of turns per unit length. Hence show

$$\text{that the energy density is given by } \frac{B^2}{2\mu_0}.$$

Ans.

$$B = \mu_0 n I$$

$$\text{Or, } B^2 = \mu_0^2 I^2 n^2$$

$$\text{Or, } I^2 = \frac{B^2}{\mu_0^2 n^2}$$

$$\text{And } L = \mu_0 n^2 l A$$

Putting in the given expression,

$$W = \frac{1}{2} LI^2$$

$$\text{Or, } W = \frac{1}{2} (\mu_0 n^2 l A) I^2$$

[substituting L]

$$\text{Or, } W = \frac{1}{2} (\mu_0 n^2 V) I^2$$

[Putting Volume =  $V = lA$ ]

Or, 
$$W = \frac{1}{2} (\mu_0 n^2 V) \times \frac{B^2}{\mu_0^2 n^2}$$
 [substituting  $I^2$ ]

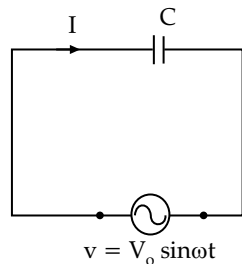
Or, 
$$W = \frac{B^2 V}{2\mu_0}$$

$\therefore$  Energy density =  $\frac{W}{V} = \frac{B^2}{2\mu_0}$

19. (a) When an a.c. source is connected to an ideal capacitor show that the average power supplied by the source over a complete cycle is zero.

(b) A lamp is connected in series with a capacitor. Predict your observations when the system is connected first across a d.c. and then an a.c. source. What happens in each case if the capacitance of the capacitor is reduced?

Ans. (a) AC source connected to a ideal capacitor:



Using KVL,

$$V_0 \sin \omega t = \frac{q}{C}$$

Or,  $q = CV_0 \sin \omega t$

Or,  $I = \frac{dq}{dt} = CV_0 \omega \cos \omega t$

$\therefore I = I_0 \cos \omega t = I_0 \sin \left( \omega t + \frac{\pi}{2} \right)$

$$\begin{aligned} \text{Average Power} &= \frac{1}{T} \int_0^T \left[ V_0 \sin \omega t \times I_0 \sin \left( \omega t + \frac{\pi}{2} \right) \right] dt \\ &= \frac{1}{T} \int_0^T \left[ \frac{1}{2} V_0 I_0 \sin 2\omega t \right] dt \\ &= 0 \end{aligned}$$

(b) Reactance of a capacitor =  $X_C = \frac{1}{2\pi fC}$

For DC,  $f = 0$ ,  $X_C = \infty$ , No current flow, bulb does not glow.

For AC,  $f \neq 0$ ,  $X_C \neq \infty$ , current flows, bulb glows.

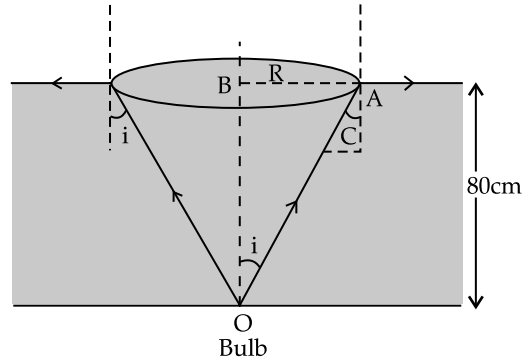
Capacitance is reduced.

For DC,  $f = 0$ ,  $X_C = \infty$ , No current flow, bulb does not glow.

For AC, as C reduces,  $X_C$  increases, current decreases, bulb glows less bright.

20. A small bulb (assumed to be a point source) is placed at the bottom of a tank containing water to a depth of 80 cm. Find out the area of the surface of water through which light from the bulb can emerge. Take the value of the refractive index of water to be  $\frac{4}{3}$ .

Ans.



Using Snell's law,

$$\mu = \frac{\sin i}{\sin r}$$

Or, 
$$\frac{4}{3} = \frac{\sin 90^\circ}{\sin r}$$

$\therefore i = \sin^{-1} \frac{3}{4} = 48.59^\circ$

Now, 
$$\tan i = \frac{AB}{OB} = \frac{R}{0.8}$$

$\therefore R = 0.8 \times \tan 48.59^\circ = 0.8 \times 1.134 = 0.9 \text{ m}$

Area of surface of water through which light will emerge

$$\begin{aligned} &= \pi R^2 = \pi \times (0.9)^2 \\ &= 2.54 \text{ m}^2 \end{aligned}$$

\* 21. What is meant by 'detection of a modulated signal'? Draw block diagram of a detector for AM waves and state briefly, showing the waveforms, how the original message signal is obtained.

OR

Write the function of each of the following used in communication system:

(i) Transducer

(ii) Repeater

(iii) Transmitter

22. (a) Define electric flux. Write its S. I. units.

(b) Consider a uniform electric field  $\vec{E} = 3 \times 10^3 \hat{i} \text{ N/C}$ .

Calculate the flux of this field through a square surface of area  $10 \text{ cm}^2$  when

(i) its plane is parallel to the  $y - z$  plane, and

(ii) the normal to its plane makes a  $60^\circ$  angle with the  $x$ -axis.

**Ans. (a) Electric flux:** Number of electric field lines crossing an area in a direction normal to it.

**SI unit:**  $\text{Nm}^2/\text{C}$

(b)  $\phi = |E|A \cos \phi$

(i) When the plane is parallel to Y-Z plane, then  $\phi = 0^\circ$

$$\therefore \phi = 3 \times 10^3 \times (0.1)^2 \cos 0^\circ = 30 \text{ Nm}^2/\text{C}$$

(ii) When normal to the plane makes an angle  $60^\circ$  with X-axis, then  $\phi = 60^\circ$

$$\therefore \phi = 3 \times 10^3 \times (0.1)^2 \cos 60^\circ = 15 \text{ Nm}^2/\text{C}$$

\* 23. (a) The number of nuclei of a given radioactive sample at time  $t = 0$  and  $t = T$  are  $N_0$  and  $\frac{N_0}{n}$

respectively. Obtain an expression for the half-life ( $T_{1/2}$ ) of the nucleus in terms of  $n$  and  $T$ .

(b) Write the basic nuclear process underlying  $\beta^-$  decay of a given radioactive nucleus.

24. (a) State three important properties of photons which describe the particle picture of electromagnetic radiation.

(b) Use Einstein's photoelectric equation to define the terms (i) stopping potential and (ii) threshold frequency.

**Ans. (a)** Properties of photon which describe the particle nature of electromagnetic radiation:

- (i) Photons are quanta or discrete packet of energy.
- (ii) Energy of photon is proportional to the frequency of the em radiation.
- (iii) Photon transfers its whole energy to the interacting electron.

(b) **Einstein's photoelectric equation:**

$$KE_{\text{max}} = h\nu - h\nu_0$$

(i)  $KE = eV_s$

If negative potential of magnitude  $V_s$  is applied to the anode then no photoelectron electron will be able to reach anode and hence the photoelectron emission will stop. This potential is known as stopping potential.

(ii) From Einstein's equation,

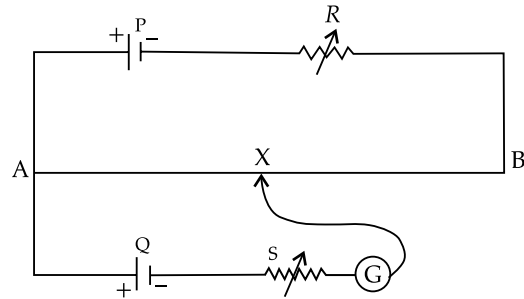
When  $\nu = \nu_0$ ,  $KE_{\text{max}} = 0$ , i.e., photoelectrons are just emitted with no kinetic energy.

When  $\nu > \nu_0$ ,  $KE_{\text{max}} > 0$ , i.e., photoelectrons are emitted with some kinetic energy.

When  $\nu < \nu_0$ ,  $KE_{\text{max}} < 0$ , which is not possible. So, no photoelectron emission takes place.

So, there is a minimum frequency below which photoelectron emission is not possible. This frequency is known as threshold frequency.

\* 25. State the underlying principle of a potentiometer. Write two factors on which the sensitivity of a potentiometer depends.



In the potentiometer circuit shown in the figure, the balance point is at X. State, giving reason, how the balance point is shifted when

- (i) resistance R is increased ?
- (ii) resistance S is increased, keeping R constant?

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

Based on the above paragraph, answer the following:

- (a) (i) Why does least distance of distinct vision increase with age?
- (ii) What type of lens is required to correct this defect?
- (b) What, according to you, are the two values displayed by Amit towards his uncle ?

**Ans. (a)** (i) Least distance of distinct vision changes with age due to following two reasons:

- Power of accommodation decreases due to weakening of ciliary muscle.
- Eye lens loses flexibility.

(ii) Convex lens is required to correct this defect (hypermetropia).

(b) Empathy and concern for elder persons.

27. \* (a) Why is the base region of a transistor thin and lightly doped ?

(b) Draw the circuit diagram for studying the characteristics of an n-p-n transistor in common emitter configuration.

Sketch the typical (i) input and (ii) output characteristics in this configuration.

(c) Describe briefly how the output characteristics can be used to obtain the current gain in the transistor.

OR

- (a) How is a depletion region formed in *p-n* junction?  
 (b) With the help of a labelled circuit diagram, explain how a junction diode is used as a full wave rectifier.

Draw its input, output wave-forms.

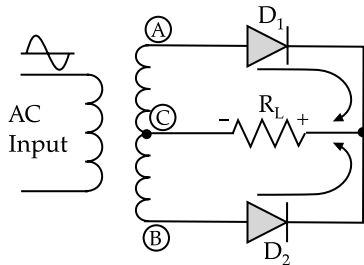
- (c) How do you obtain steady d.c. output from the pulsating voltage?

Ans. OR

- (a) Formation of depletion region:

When *p* type and *n* type semiconductors are brought in contact, electrons diffuse from *n*-side to *p*-side and holes diffuse from *p*-side to *n*-side. This is due to the higher concentration of holes in *p*-side and higher electron concentration in *n*-side. The electrons and holes cross the junction and recombine with each other. Thus a certain region of both side of the actual junction becomes depleted from free charge carriers. There remain only immobile positive ions in *n*-side and immobile negative ions in *p*-side which restrict further electrons and holes to cross the junction. Thus a depletion region is formed.

- (b) Full wave rectifier:



A full wave rectifier is constructed using two *p-n* junction diodes, a centre-tapped transformer and a load resistor.

Anodes of the diodes are connected at the two end terminals of the secondary of the transformer.

Cathodes of the diodes are joined together and connected to the centre tap of the transformer through the load resistor.

AC is fed to the input of the transformer.

For the positive half cycle of AC, A is +ve, C is 0 and B is -ve.

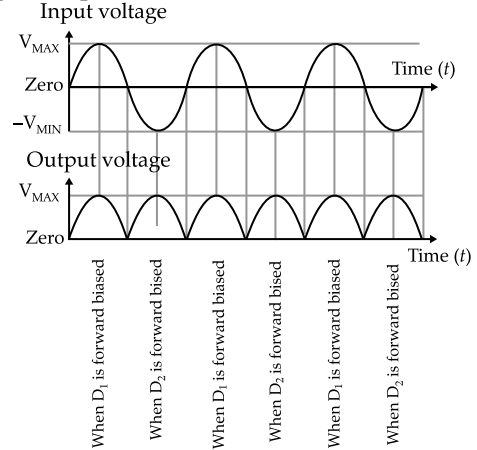
So,  $D_1$  is forward biased and  $D_2$  is reverse biased. Current flows only through  $D_1$  in the direction as shown.

For the negative half cycle of AC, A is -ve, C is 0 and B is +ve.

So,  $D_2$  is forward biased and  $D_1$  is reverse biased. Current flows only through  $D_2$  in the direction as shown.

So, in both the cases, the direction of current through load resistor is in the same direction. So, a direct potential difference i.e., DC voltage is developed across the resistor.

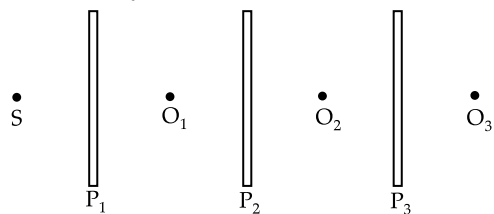
**Input Output waveform:**



- (c) To obtain steady DC output from the pulsating voltage, filter is to be used. Capacitor in parallel is an effective filter.

28. \* (a) Describe briefly how an unpolarized light gets linearly polarized when it passes through a polaroid.

- (b) Three identical polaroid sheets  $P_1$ ,  $P_2$  and  $P_3$  are oriented so that the pass axis of  $P_2$  and  $P_3$  are inclined at angles of  $60^\circ$  and  $90^\circ$  respectively with respect to the pass axis of  $P_1$ . A monochromatic source S of unpolarized light of intensity  $I_0$  is kept in front of the polaroid sheet  $P_1$  as shown in the figure. Determine the intensities of light as observed by the observers  $O_1$ ,  $O_2$  and  $O_3$  as shown.

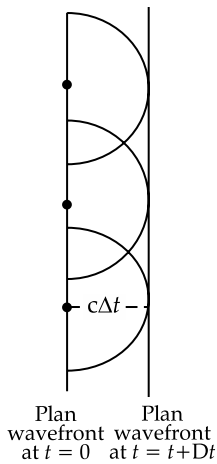


OR

- (a) Use Huygens geometrical construction to show how a plane wave-front at  $t = 0$  propagates and produces a wave-front at a later time.  
 (b) Verify, using Huygens principle, Snell's law of refraction of a plane wave propagating from a denser to a rarer medium.  
 (c) When monochromatic light is incident on a surface separating two media, the reflected and refracted light both have the same frequency. Explain why.

Ans. OR

(a) m



(b) Proof of Snell's law of refraction:

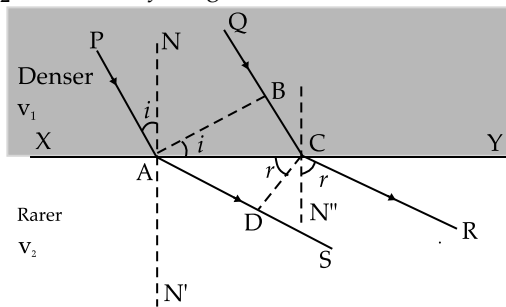
XY is the separation of two media.

AB is the incident wavefront

CD is the refracted wavefront.

$v_1$  is the velocity of light in denser medium.

$v_2$  is the velocity of light in rarer medium.



$$\angle PAN = \angle i = \text{angle of incidence} \\ = \angle BAC$$

$$\angle RCN'' = \angle r = \text{angle of refraction} \\ = \angle ACD$$

In  $\triangle ABC$ ,

$$\sin i = \frac{BC}{AC} = \frac{v_1 t}{AC}$$

In  $\triangle ACD$ ,

$$\sin r = \frac{AD}{AC} = \frac{v_2 t}{AC}$$

$$\therefore \frac{\sin i}{\sin r} = \frac{v_1}{v_2}$$

= Refractive index of rarer medium  
with respect to denser medium.

This Snell's law of refraction.

(c) Reflection and refraction occur due to the interaction of light with the atoms / molecules of the media which vibrate with the same frequency

of the incident light. For this the reflected and refracted light have the same frequency as that of incident light.

29. State Biot-Savart law, expressing it in the vector form. Use it to obtain the expression for the magnetic field at an axial point, distance ' $d$ ' from the centre of a circular coil of radius ' $a$ ' carrying current ' $I$ '. Also find the ratio of the magnitudes of the magnetic field of this coil at the centre and at an axial point for which  $d = a\sqrt{3}$ .

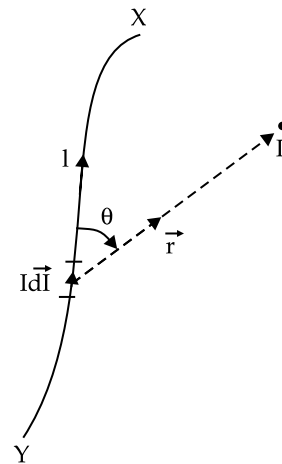
OR

(a) Draw the magnetic field lines due to a current carrying loop.

(b) State using a suitable diagram, the working principle of a moving coil galvanometer. What is the function of a radial magnetic field and the soft iron core used in it?

(c) For converting a galvanometer into an ammeter, a shunt resistance of small value is used in parallel, whereas in the case of a voltmeter a resistance of large value is used in series. Explain why.

Ans. Biot-Savart law:



XY is a current carrying wire.

$\vec{dl}$  is a small element on it.

At point P, whose position vector is  $\vec{r}$ , the magnetic field is to be determined.

According to Biot Savart law, the magnitude of magnetic field  $\vec{dB}$  at P is

(i) Proportional to current I

(ii) Proportional to length dl

(iii) Inversely proportional to the square of the distance of the point

The direction of magnetic field is perpendicular to the plane containing  $\vec{dl}$  and  $\vec{r}$ .

In vector form,

$$\vec{dB} \propto \frac{I dl \times \vec{r}}{r^3}$$

Or, 
$$\vec{dB} = \frac{\mu_0}{4\pi} \frac{I dl \times \vec{r}}{r^3}$$

Magnetic field due to a current carrying circular coil:

A single turn circular coil of radius  $a$  carrying current  $I$  is considered.  $P$  is a point on the axis at a distance  $d$  where the magnetic field is to be determined.

Two small lengths  $dl$  are considered at two diametrical opposite ends on the coil.

Distance of point  $P$  from  $dl$  is  $r$ .

If  $dB$  is the magnetic field, then

$$dB = \frac{\mu_0}{4\pi} \frac{I dl \sin 90^\circ}{r^2}$$

$$= \frac{\mu_0}{4\pi} \frac{I dl}{r^2}$$

The 2 components of  $dB$  are  $dB \cos \phi$  and  $dB \sin \phi$ .

The two  $dB \cos \phi$  components corresponding to two  $dl$  elements (at the upper and the lower end) cancel each other.

The two  $dB \sin \phi$  components are in same direction and hence resultant magnetic field at  $P$  becomes  $2dB \sin \phi$ .

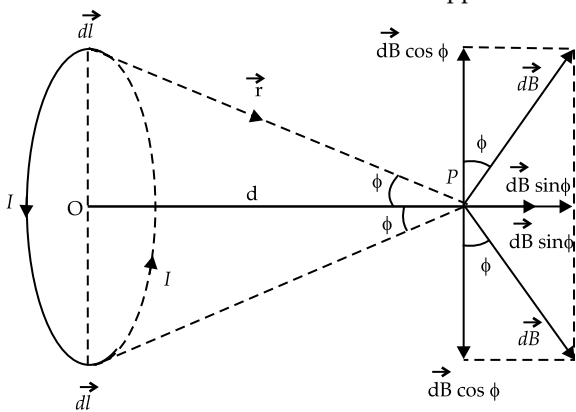
So, the resultant magnetic field at point  $P$  due to the entire coil is

$$B = \frac{\mu_0}{4\pi} \sum \frac{2I dl \sin \phi}{r^2}$$

Or, 
$$B = \frac{\mu_0}{4\pi} \frac{2I \sin \phi}{r^2} \sum dl$$

Or, 
$$B = \frac{\mu_0}{4\pi} \frac{2I \sin \phi}{r^2} \times \pi a$$

[since at a time two  $dl$  portions have been considered at two diametrical opposite ends.]



Or, 
$$B = \frac{\mu_0}{4\pi} \frac{2I \times \frac{a}{r}}{r^2} \times \pi a$$

[since,  $\sin \phi = \frac{a}{r}$ ]

Or, 
$$B = \frac{\mu_0}{4\pi} \frac{2\pi a^2 I}{r^3}$$

Or, 
$$B = \frac{\mu_0}{2} \frac{a^2 I}{(a^2 + d^2)^{3/2}}$$

**Ratio of magnetic fields:**

When 
$$d = a\sqrt{3}$$

$$B_P = \frac{\mu_0}{2} \frac{a^2 I}{[a^2 + (a\sqrt{3})^2]^{3/2}}$$

$$= \frac{\mu_0}{2} \times \frac{I}{8a}$$

At centre ( $d = 0$ )

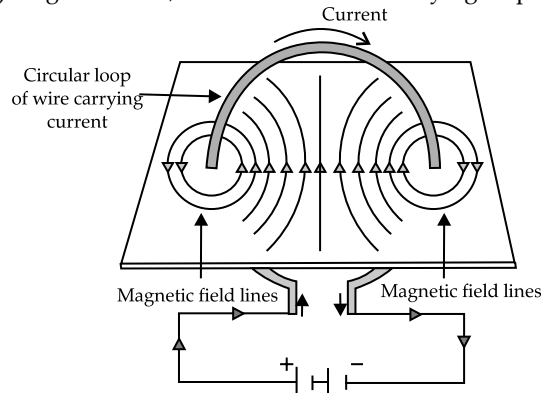
$$B_{\text{centre}} = \frac{\mu_0}{2} \times \frac{a^2 I}{(a^2)^{3/2}}$$

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

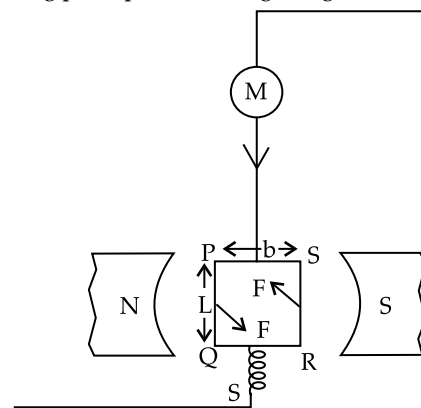
So, the ratio =  $\frac{B_{\text{centre}}}{B_P} = 8 : 1$

**OR**

(a) Magnetic field ;lines due to current carrying loop:



(b) Working principle of Moving coil galvanometer:



PQRS is a rectangular coil, of copper wire of length  $L$  and breadth  $b$ , having  $n$  number of turns, current  $i$  flowing through it, is hung in a permanent magnetic field  $B$  with the help of a phosphor bronze strip.

Force acting on  $PQ$  and  $SR$  is  $F = nBiL$ . These two forces are oppositely directed.



So, the moment of deflecting couple is

$$\tau = f \times b = nBilb$$

As the coil rotates, a restoring torque  $c\theta$  is produced in the phosphor bronze strip, where  $c$  is the torsional constant and  $\theta$  is the angle of twist.

At equilibrium,  $c\theta = nBilb$

Or, 
$$c\theta = nBiA \quad (A = \text{area of the coil})$$

Or, 
$$i = \frac{c\theta}{nBA}$$

Or, 
$$i = k\theta$$

$$(k = \frac{c}{nBA} = \text{Galvanometer constant})$$

$\therefore i \propto \theta$

**Function of radial magnetic field:** Due to radial magnetic field, magnetic field lines become perpendicular to magnetic moment and hence the torque becomes maximum.

**Function of soft iron core:** Using soft iron core sensitivity increases since the magnetic field lines prefer to pass through soft iron.


(c) A shunt resistance of small value is connected in parallel with a galvanometer to convert it to an ammeter. Ammeter is used in series in a circuit. Its resistance should be as low as possible so that it does not make any change in the circuit current. So, a low resistance is connected in parallel with the galvanometer to achieve this.

A high value resistance is connected in series with a galvanometer to convert it to a voltmeter. Voltmeter is used in parallel to a component in a circuit. Its resistance should be as high as possible so that it does not make any change in the circuit current. So, a high value resistance is connected in series with the galvanometer to achieve this.





## Don't Stop Reading !

You never know what might be asked in the exam.





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