SAMPLE PAPER-03
PHYSICS (Theory)
(Questions)
Class – XII

Time allowed: 3 hours Maximum Marks: 70

General Instructions:

a) All the questions are compulsory.
b) There are **26** questions in total.
c) Questions **1** to **5** are very short answer type questions and carry **one** mark each.
d) Questions **6**to **10** carry **two** marks each.
e) Questions **11** to **22** carry **three** marks each.
f) Questions **23** to **26** carry **five** marks each.
g) 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 in five marks each. You have to attempt only one of the choices in such questions.
h) Use of calculators is **not** permitted. However, you may use log tables if necessary.
i) You may use the following values of physical constants wherever necessary:

$c = 3x10^{8} m/s$

$h = 6.63x10^{-34} Js$

$e = 1.6x10^{-19} C$

$\mu_o = 4\pi x10^{-7} TmA^{-1}$

$\frac{1}{4\pi\varepsilon_0} = 9x10^{9} Nm^2C^{-2}$

$m_e = 9.1x10^{-31} kg$

---

1. Explain the significance of direction of electric current in a circuit?
2. The horizontal component is $\sqrt{3}$ times the vertical component of earth's magnetic field at a place. What is the angle of dip at that place?
3. Why sky waves are not used in the transmission of television signals?
4. Draw the block diagram of basic element of communication system.
5. An electron and a proton have same De Broglie wavelength associated with them. How are their K.E. related to each other?
6. Explain the effect of increase of intensity and potential difference on photoelectrons K.E.?
7. Explain why when current is in circular, the magnetic field is straight.

Or

An electron is describing a circle in a magnetic field of 10^{-4} tesla. Calculate the frequency of revolutions. Given mass of electron = 9×10^{-31} kg and charge on electron = 1.6×10^{-19} C.

8. Calculate the number of photons emitted per second by transmitter of 10 KW power, radio wave frequency of 6×10^5Hz.
9. Draw a sketch of a plane electromagnetic wave propagating along x axis. Depict clearly the direction of electric and magnetic field varying sinusoid ally.
10. Calculate current drawn by the primary of a transformer which steps down 200V to 20V to operate a device of resistance 20Ω. Assume the efficiency of transformer to be 80%.
11. A proton and an alpha particle having the same K.E. are in turn allowed to pass through a uniform magnetic field perpendicular to their direction of motion compare the radii of paths of proton and α particle.
12. A double convex lens made of glass if refractive index 1.5 has its both surface of equal radii of curvature of 20cm each. An object of 5cm height is placed at a distance of 10cm from the lens. Find the position nature and size of image.
13. A magnetized steel wire 31.4 cm long has pole strength of 0.2 Am. It is then bent in the form of a semicircle. Calculate magnetic moment of the needle.

Or

Two magnetic poles, one of which is four times stronger than the other exert a force of 10 gf on each, when placed at a distance of 10 cm in air. Find the strength of each pole.

14. A cyclotron's oscillator frequency is 10 MH_Z what should be the operating magnetic field for accelerating protons? If the radius of its disc is 0.60 m what is the kinetic energy of the proton beam produced by the accelerator? ($e=1.6 \times 10^{-19}$ C, $m = 1.67 \times 10^{-27}$ kg). Express your answer in units of MeV.($1 \text{ MeV} = 1.602 \times 10^{-13}$J)
15. What is meant by sensitivity of a potentiometer? A battery E_1 of 4V and variable resistance R are connected in series with wire AB. Length of wire is 1m. When cell of emfE_2 = 1.5V is connected b/w A & C, no current flows through E_2 length of AC is 60cm.
    (i) Find the potentiometer difference b/w A & B.
    (ii) Would the method work if the battery E_1 is replaced by a cell of emf of 1V.
16. Derive an expression for the impedance of an a.c. circuit with series L.C.R. combination
17. Calculate the de Broglie wavelength for electrons and protons if their speed is 10^5 m s^{-1}?
18. Give reason for the following – Lighter elements are better moderators for a nuclear reactor than heavier elements?

19. Why do we require modulation? Explain the AM with block diagram.

20. State the principle of potentiometer. Draw a circuit diagram used to compare the emf of two primary cells. Write the formula used?

21. Three light rays red (R), green(G) and blue (B) are incident on a right angled prism ABC at face 'AB' the refractive index of the material of the material of prism for red., green and Blue wavelength are 1.39, 1.44 respectively. Out of three which ray will emerge out of face AC.

22. Draw a diagram to show the behaviour of magnetic field lines ear a 'bar' of (i) copper (ii) Aluminium and (iii) mercury cooled to a very low temperature.

23. Shyam was given a square of each side 1.0m with four charges+1 x 10^{-8} C, -2 x 10^{-8} C, + 3 x 10^{-8} C and +2 x 10^{-8} C. His teacher asked him to find,

a) The potential at the centre of the square.

b) Potential energy of the system of four charges.

24. Coulomb's law for electrostatic force between two point charges and Newton's law for gravitational force between two stationary point masses, both have inverse-square dependence on the distance between the charges/masses.

i) Compare the strength of these forces by determining the ratio of their magnitudes (a) for an electron and a proton and (b) for two protons.

ii) Estimate the accelerations of electron and proton due to the electrical force of their mutual attraction when they are 1 Å (= 10^{-10} m) apart? (m_p= 1.67 × 10^{-27} kg, m_e= 9.11 × 10^{-31} kg)

Or

A straight thick long wire of uniform cross section of radius 'a' is carrying a steady current I.

a) Use Ampere's circuital law to obtain a relation showing the variation of the magnetic field (Br) inside and outside the wire with distance r,
(r ≤ a) and (r > a) of the field point from the centre of its cross section.

b) Plot a graph showing the nature of this variation.

c) Calculate the ratio of magnetic field at a point a/2 above the surface of the wire to that at a point a/2 below its surface.

d) What is the maximum value of the field of this wire?

25. Draw a graph to show the variation of angle of deviation D with that of the angle of incidence i for a monochromatic ray of light passing through a glass prism of refracting angle A. hence deduce relation, $\mu = \sin\left(\frac{\frac{A + \delta_m}{2}}{\sin\frac{A}{2}}\right)$

Or

With the help of diagram explain the basic principle of working a.c. generator. In an a.c. generator coil of N turns and area A is rotated at rotation per second in a uniform magnetic field B. Write the expression of the emf produced.

26. Differentiate ammeter and voltmeter.

Or

a) The earth's magnetic field varies from point to point in space. Does it also change with time? If so, on what time scale does it change appreciably?

b) A system displaying a hysteresis loop such as a Ferro magnet is a device for storing memory. Explain.

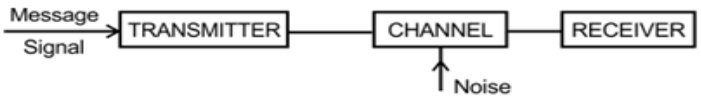
c) Does the magnetisation of a paramagnetic salt depend on temperature? Justify your answer.

d) Give the basic use of hysteresis curve.

SAMPLE PAPER-03
PHYSICS (Theory)
Class – XII

Time allowed: 3 hours Maximum Marks: 70

Solutions

1. The conventional direction of electric current in a circuit tells the direction of flow of positive charge. The direction of flow of electrons gives the direction of electronic current, which is opposite to that of conventional current.
2. BH = $\sqrt{3}$ Bv -> B cosθ = $\sqrt{3}$ B sin θ
   tanθ = $1/\sqrt{3} \rightarrow \theta = 30^0$
3. Television signals are of high frequencies, they can be reflected to earth by ionosphere whereas sky waves are reflected from ionosphere.
4. 

5. $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mk}} \Rightarrow K_p < K_e$
6. This is due to the increase in intensity, no effect on K.E. of photo electrons as well as on potential difference. As due to increase in intensity there is only an increase in the number of photons per unit area and not the energy incident.
7. When a current is circular, it means the current is passing through a circular coil. The magnetic field produced due to the current through circular coil is in the form of straight and parallel magnetic lines of force at the centre of the circular coil, lying in a plane perpendicular to the plane of coil. It means the magnetic field is straight at the centre of the circular coil carrying current.

   Or

   Given B = 10^{-4} T then v =?

   m = 9 x 10^{-31} kg

   e = 1.6 x 10^{-19} C

   $$Bev = \frac{mv^2}{r}$$

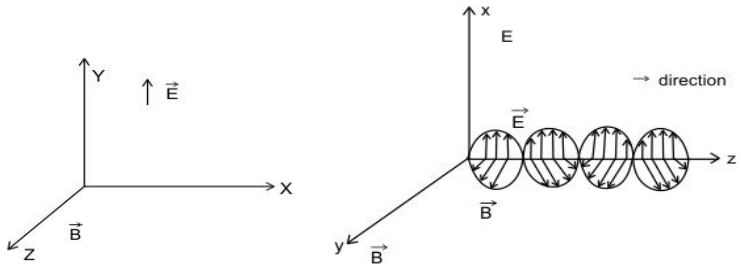
   $$v = \frac{Be}{2\pi m} = \frac{10^{-14}\, x1.6x10^{-19}}{2x3.14x9x10^{-31}} = 2.83x10^6\, Hz$$

8. $E = n\frac{hc}{\lambda} = nh\upsilon$

$10 \text{ x } 1000 = n \text{ x } 6.6 \text{ x } 10^{-34} \text{ x } 6 \text{ x } 10^{5}$

$$n = \frac{10000}{6.6 \text{ x } 6 \text{ x } 10^{-29}} = 2.5 \text{ x } 10^{31} \text{ per second}$$

9.



10. $V_P = 200$ V $\quad \eta = 80\%$

$V_S = 20$v

R =20Ω

$$\eta = \frac{V_p I_p}{V_s I_s} = \frac{V_p I_p}{V_s \frac{V_s}{R}} = \frac{V_p I_p R}{V_s^2}$$

$$I_p = \eta \frac{V_s^2}{V_p R} = \frac{80}{100} \text{ x } \frac{20 \text{ x } 20}{200 \text{ x } 20} = 0.08A$$

11.

$$r = \frac{mv}{qB} = \frac{p}{qB} = \frac{\sqrt{2mk}}{qB} = \frac{\sqrt{2mqv}}{qB}$$

$$\frac{r_p}{r_d} = \sqrt{\frac{m_p}{m_\alpha}\frac{q_\alpha}{q_p}} = \sqrt{\frac{m_p}{4m_p}\frac{2q_p}{q_p}}$$

$$\frac{r_p}{r_\alpha} = \frac{q}{\sqrt{2}}$$

12. $\mu_{ga} 1.5 R_1 = R_2 = 20cm$

$h_1 = 5$ cm, u = - 10 cm

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{v} - \frac{1}{u}$$

$$\Rightarrow (1.5-1)\left(\frac{1}{20}-\frac{1}{-20}\right)=\frac{1}{v}-\frac{1}{-10}$$

$$\Rightarrow 0.5 \text{ x } \frac{2}{20}=\frac{1}{v}+\frac{1}{10}$$

$$\Rightarrow \frac{1}{v}=\frac{1}{10}-\frac{1}{20}=\frac{1}{20}$$

$$\Rightarrow v=20cm$$

$$\therefore m=\frac{h_2}{h_1}=\frac{v}{u}$$

$$h_2=\frac{v}{u}h_1=\frac{20}{-10} \text{ x } 5$$

$$\mathrm{h}_2=-10cm$$

13. Given L = 31.4 cm

m = 0.2 Am

M =?

When the wire is bent in the form of a semicircle of radius r

$$L=\pi r=3.14r$$

$$r=\frac{L}{3.14}=\frac{31.4}{3.14}=10cm$$

Distance between the two ends of wire

2*l* = 2r = 20 cm = 0.2 m

M = m x 2l = 0.2 x 0.2 = 0.04 Am^2

Or

Given m_1 = m,m_2 = 4 m

r = 10 cm = 0.1 m

F = 10gf = 10^{-2} x 9.8 N

$$F=\frac{\mu_0}{4\pi}\frac{m_1m_2}{r^2}$$

$$9.8 \text{ x } 10^{-2}=10^{-7}\frac{m(4m)}{(0.1)^2}$$

$4m^2$ = 9800 m^2 = 2450

m = 49.5 Am

Strength of one pole = 49.5 Am

Strength of other pole = 4 x 49.5 = 198 Am

14.

Condition for resonance is $v = \frac{Be}{2\pi m}$

or $B = \frac{2\pi mv}{e} = \frac{2\times3.14\times1.67\times10^{-27}\times10\times10^{6}}{1.6\times10^{-19}}$

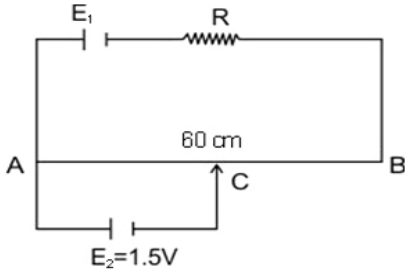
tesla $= 0.655$ tesla

maximum kinetic energy $= \frac{B^2e^2r_m{}^2}{2m}$

$= \frac{(0.655)^2\times(1.6\times10^{-19})^2(0.6)^2}{2\times1.67\times10^{-27}}$ J $= 1.18\times10^{-12}$ J

$= \frac{1.18\times10^{-12}}{1.6\times10^{-13}}$ Mev $= 7.4$ MeV

15. Sensitivity – sensitivity of a potentiometer is related to potential gradient smaller the potential gradient, more sensitive be the potentiometer.



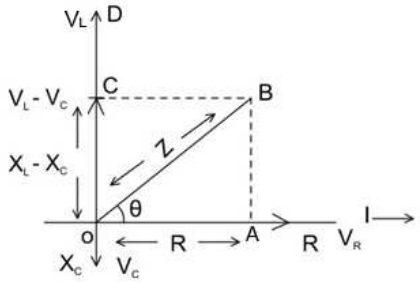
(i) $E_2 = KI_2$

$1.5 = K \times 60 \times 10^{-2}$

$K = \frac{1.5}{60 \times 10^{-2}} = \frac{150}{60} = 2.5$

(ii) No, as current is lowered as emf of driver cell is less than balancing cell.

16.



$OA = V_R$, $OD = V_L$, $OE = V_C$, $OC = V_L - V_C$

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

$= i^2[R^2 + (X_L - X_C)^2]$

$$V = i\sqrt{R^2 + (X_L - X_C)^2}$$

$$\Rightarrow \frac{V}{i} = \sqrt{R^2 + (X_L - X_C)^2}$$

= total resistance offered 'p' impedance

17. Mass of electron = 9 x 10^{-31} kg

De Broglie wavelength $\lambda_e = \frac{h}{mv}$

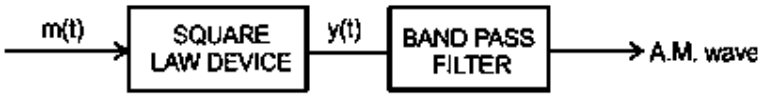
$$\lambda_e = \frac{6.63x10^{-34}}{9x10^{-31}x10^5} m = 7.4x10^{-9} m$$

Mass of proton = 1.67 x 10^{-27} kg

$$\lambda_p = \frac{h}{mv} = \frac{6.63x10^{-34}}{1.67x10^{-27}x10^5} m = 3.97x10^{-12} m$$

18. The neutrons produced by fission are fast, with kinetic energy of about 2 MeV. However, fission is induced most effectively by thermal neutrons. The fast neutrons can be slowed down by mixing the uranium fuel with a substance called moderator. It have two properties.
    a. It should be effective in slowing neutrons via elastic collisions. If a moving particle has a head on elastic collision with a stationary particle, the moving particle loses all its kinetic energy if the two particles have the same mass.
    b. The moderator should not absorb neutrons.

19. As for transmission of signals size of antenna L = λ /4 = C / 4υ, which is too large and hence reduces the size of antenna. Frequency other characteristics such as amplitude phase, should be modified and the process is known as modulation.

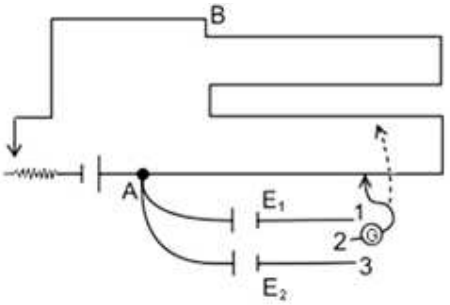


20. If potential difference is applied b/w the ends of a resistance wire of uniform cross section then potential drops along the two ends of wire is directly proportional length.

Vα L

$$\frac{V}{L} = \text{constant} = K$$

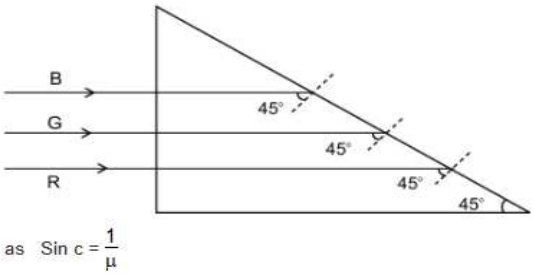
$$\frac{E_1}{E_2} = \frac{I_1}{I_2}$$



21. $\mu_R = 1.39$, $\mu_B = 1.47$, $\mu_G = 1.44$

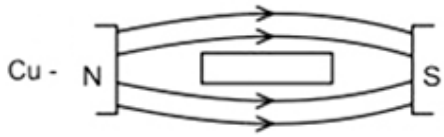
$C_R = 44^0$, $C_B = 46.3^0$, $C_G = 48.8^0$

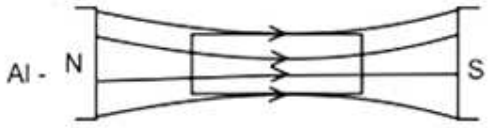
Therefore, $\angle i > \angle c$ for red colour, it will reflect.



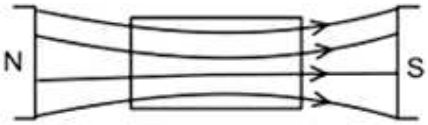
as $\text{Sin } c = \frac{1}{\mu}$

22.





Hg at 1000 temp



23.

a. The value of diagonals of the square = $\sqrt{2}$m

From the centre to the all the corners = $\frac{1}{\sqrt{2}}$ m

Now using the formula, $V = \frac{\Sigma q}{4\pi\varepsilon_0 r}$

Substituting the values, we get $V = 5.09 \times 10^2$ V

b. Using the formula, $\frac{q_1 q_2}{4\pi\varepsilon_0 r}$

Substituting the values, we get Potential energy = $- 6.4 \times 10^{-7}$J

24.

i) a) The electric force between an electron and a proton at a distance r apart is

$$F_e = -\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2}$$

Where the negative sign indicates that the force is attractive and the corresponding gravitational force is

$$F_G = - G\frac{m_p m_e}{r^2}$$

Where m_p and m_e are the masses of a proton and an electron respectively

$$\left|\frac{F_e}{F_G}\right| = \frac{e^2}{4\pi\varepsilon_0 G m_p m_e} = 2.4 \times 10^{39}$$

b) On similar lines, the ratio of the magnitudes of electric force to the gravitational force between two protons at a distance r apart is

$$\left|\frac{F_e}{F_G}\right| = \frac{e^2}{4\pi\varepsilon_0 G m_p m_e} = 1.3 \times 10^{36}$$

However, it may be mentioned here that the signs of the two forces are different. For two protons, the gravitational force is attractive in nature and the Coulomb force is repulsive. The actual values of these forces between two protons inside a nucleus (distance between two protons is $\sim 10^{-15}$ m inside a nucleus) are $F_e \sim 230$ N whereas $F_G \sim 1.9 \times 10^{-34}$ N. The (dimensionless) ratio of the two forces shows that electrical forces are enormously stronger than the gravitational forces.

ii) The electric force F exerted by a proton on an electron is same in magnitude to the force exerted by an electron on a proton; however the masses of an electron and a proton are different. Thus, the magnitude of force is

$$|F| = -\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2} = \frac{8.987 \times 10^9}{\frac{1.6 \times 10^{-19}}{10^{-10}}} = 2.3 \times 10^{-8} \text{ N.}$$

Using Newton's second law of motion, $F = ma$, the acceleration that an electron will undergo is

$$a = \frac{2.3 \times 10^{-8}}{9.11 \times 10^{-31}} = 2.5 \times 10^{22} \text{m/s}^2$$

Comparing this with the value of acceleration due to gravity, we can conclude that the effect of gravitational field is negligible on the motion of electron and it undergoes very large accelerations under the action of Coulomb force due to a proton. The value for acceleration of the proton is

$$a = \frac{2.3 \times 10^{-8}}{1.67 \times 10^{-27}} = 1.4 \times 10^{19} \text{m/s}^2$$

Or

Consider a closed path of radius r inside the cross section of the wire. The current enclosed by this path is

$$I' = \left(\frac{I}{\pi a^2}\right)\pi r^2 = I\frac{r^2}{a^2}$$

Therefore, by Ampere's circuital law,

$$\phi \overrightarrow{B_r}, dl = \mu_0 I'$$

$$B_r 2\pi r = \mu_0 I \frac{r^2}{a^2}$$

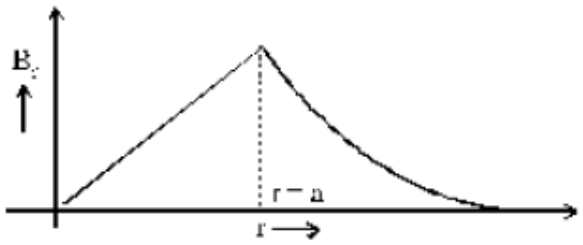
$$\therefore B_r = \frac{\mu_0 I}{2\pi a^2} r \quad [\because \text{B}\alpha\text{r, for r < a}]$$

Outside the wire, the field of the wire is given by,

$$B.2\pi r = \mu_0 I$$

$$\therefore B = \frac{\mu_0 I}{2\pi r} \quad [\text{for r > a}]$$

The graph is shown as follows:



Therefore, B_1 and B_2 denote respectively, the values of the magnetic field points a/2 above and a/2 below the surface of the wire,

$$B_1 = \frac{\mu_0 I}{2\pi\left(3\frac{a}{2}\right)} = \frac{\mu_0 I}{3\pi a}$$

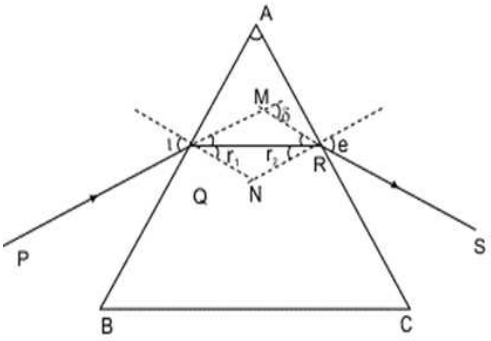
$$B_2 = \frac{\mu_0 I}{2\pi a^2} = \frac{a}{2} = \frac{\mu_0 I}{4\pi a}$$

$$\therefore \frac{B_1}{B_2} = \frac{4}{3}$$

The maximum value of the field is at r = a, we have

$$B_{max} = \frac{\mu_0 I}{2\pi a}$$

25.



$\delta = (i - r_1) + (e - r_2)$

$\delta = (i + e) - (r_1 + r_2) - - - - - (1)$

In ΔQNR,

$r_1 + r_2 + \angle N + = 180 = \angle A + \angle N$

$\angle N + = 180 = \angle A + \angle N$

$\Rightarrow r_1 + r_2 = \angle A - - - - - - (2)$

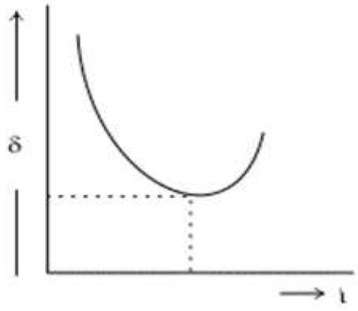
$\delta = i + e - A$

For minimum angle of deviation,

$\angle i = \angle e \quad \& \quad r_1 = r_2$

$\Rightarrow \delta_m = 2i - A$

$\Rightarrow i = \frac{\delta_m + A}{2} \& r = \frac{A}{2}$

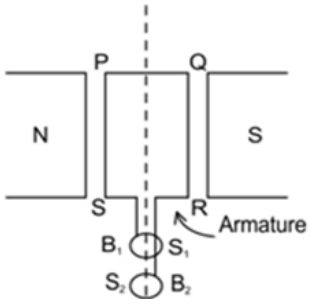


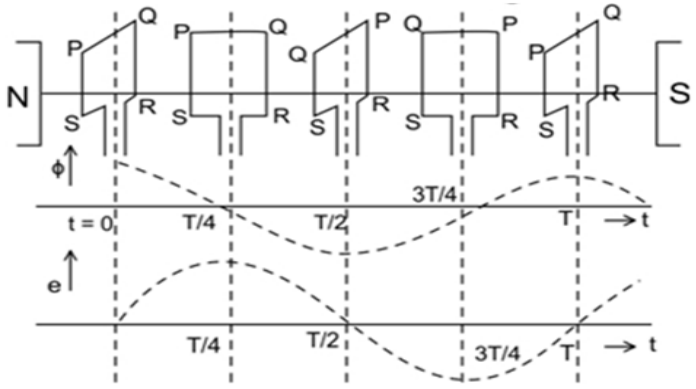
$\therefore$ Refractive index $\mu = \frac{\sin i}{\sin r} = \frac{\sin\left(\frac{A + \mu_m}{2}\right)}{\sin\frac{A}{2}}$

Or

Principle

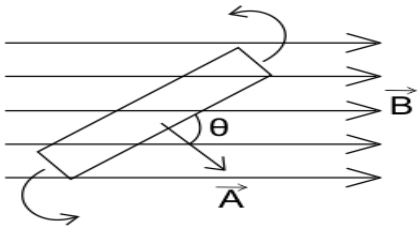
When a coil is rotated in a uniform magnetic field with a uniform angular velocity w flux linked with coil changes and emf is induced.





Induced emf e = $e_0$sinwf

= NBA w sinwf



Let θ be angle between $\vec{B}$ and $\vec{A}$ at anytime t = wf, θ = wt

As $\frac{d\theta}{dt}$ = w,

Let N be the number of turns in the coil, $\theta = \vec{B}.\vec{A}$

$= N\left(\vec{B}.\vec{A}\right)$ = NAB cos θ

Induced emf e = $-\frac{d\phi}{dt} = -\frac{d}{dt}$(NAB cos θ) = NAB (sin wt) w

E = NAwB sin wt

= e_o sin wt

26.

S. No	Ammeter	Voltmeter
1.	It is a low resistance instrument.	It is a high resistance instrument.
2.	It is always connected in series.	It is always connected in parallel.
3.	The resistance of an ideal ammeter is zero.	The resistance of an ideal voltmeter is infinity.
4.	It is not possible to decrease the range of a given ammeter.	It is possible to decrease the range of a given voltmeter.
5.	Since ammeter is a parallel combination of galvanometer and shunt resistance therefore, the resistance of the ammeter is less than that of the galvanometer.	Since voltmeter is a series combination of galvanometer and resistance therefore the resistance of the voltmeter is greater than that of the galvanometer.

Or

a) Yes, it does change with time. Time scale for appreciable change is roughly a few hundred years. But even on a much smaller scale of a few years, its variations are not completely negligible.

b) Magnetisation of a ferromagnet is not a single valued function of the magnetising field. Its value for a particular field depends both on the field and also on the history of the magnetisation.

c) The atoms of a paramagnetic substance possess small magnetic dipole moments. But these atomic dipoles are oriented in a random manner. In the presence of the external magnetic field, these dipoles tend to align in the direction of the field. But the tendency for alignment is hindered by thermal agitation. So, the magnetisation of paramagnetic salt decreases with increase in temperature.

d) Hysteresis loop gives useful information about the different properties, of materials such as coercivity, retentivity, energy loss. This information helps us in the suitable selection of materials for different purposes.