# QUARTERLY EXAMINTION 2024(Q&A)

## PHYSICS ($12^{TH}$ STD)

## Thiruvannamalai district

**PART-A**

**Choose the correct answer and write it with option**

1. The value of dielectric strength of air is

a) $9 \times 10^9\ NmC^{-2}$ b) $3 \times 10^{-6} Vm^{-1}$
c) $1.602 \times 10^{-19}\ C$ d) $4\pi \times 10^{-7} Hm^{-1}$

**ANS:** $b)3 \times 10^{-6} Vm^{-1}$

2. An electric dipole is placed at an alignment angle of 30° with an electric field of $2 \times 10^5$ N $C^{-1}$. It experiences a torque equal to 8 N m. The charge on the dipole if the dipole length is 1 cm is

a)4 mC b)8 mC c) 5 mC d)7 mC

**ANS:** $b)8mC$

3. The ratio of maximum and minimum resistance obtained by combining 'n; resistors ,each resirtance R is

a) n b) $n^2$ c) $\frac{1}{n}$ d) $\frac{1}{n^2}$

**ANS:** $b)n^2$

4. In Joule's heating law, when R and t are constant, if the H is taken along the y axis and $I^2$ along the x axis, the graph is

a) straight line b) parabola c)circle d)ellipse

***ANS: a) straight line***

5. The quantity which increased in step-down ideal transformer is

a) current b)voltage c)power d) Frequency

**ANS:** $a)current$

6. A non-conducting charged ring carrying a charge of q, mass m and radius r is rotated about its axis with constant angular speed ω. Find the ratio of its magnetic moment with angular momentum is

a) $\frac{q}{m}$ b) $\frac{2q}{m}$ c) $\frac{2q}{m}$ c) $\frac{q}{4m}$

**ANS:** c) $\frac{q}{2m}$

7. The potential energy of magnetic dipole whose dipole moment is $\vec{p_m} = -(0.5\hat{\imath} + 0.4\hat{\jmath})\ Am^2$ Am kept in uniform magnetic field $\vec{B} = -0.2\hat{\imath}\ T$

a) -0.1J b) -0.8J c) 0.1J d) 0.8J

**ANS:** $c)0.1J$

8. In a series RL circuit, the resistance and inductive reactance are the sameThen the phase difference between the voltage and current in the circuit is

a) $\frac{\pi}{4}$ b) $\frac{\pi}{2}$ c) $\frac{\pi}{6}$ d) Zero

**ANS:** $a)\frac{\pi}{4}$

9. Which of the following is an electromagnetic wave?

a) $\gamma - rays$ b)β-rays

c) $\alpha - rays$ d) all of them

**ANS:** $a)\gamma - rays$

10 .The speed of light in an isotropic medium depends on,

a)its intensity b) its wave length
c) the nature of the propagation

d)the motion of the source with respect to medium

**ANS:** ***b) its wave length***

11. A metal coin is at the bottom of the beaker filled with liquid to a height of 6cm. The refractive index of the liquid is 4/3. To an observer looking above the surface of the liquid the coin will appear raised to by

a)4.5 cm b) 6.75cm c) 1.5cm d) 7.5cm

**ANS: c) 1.5 cm**

12.If the amplitude of the magnetic field is 3 × $10^{-6}$ T, then amplitude of the electric field for a electromagnetic waves is

$a)\ 100Vm^{-1}$ $b)300Vm^{-1}$

$c)600Vm^{-1}$ $d)900Vm^{-1}$

**ANS: d) $900Vm^{-1}$**

13. A parallel plate capacitor stores a charge Q at a voltage V. Suppose the area of the parallel plate capacitor and the distance between the plates are each doubled then which is the quantity that will change?

a) Capacitance b) charge
b) c) voltage d) energy density

**ANS: d)energy density**

14. The temperature coefficient of resistance of a wire is 0.00125 per °C. At 20°C, its resistance is 1 Ω. The resistance of the wire will be 2 Ω at

$a)$ 800°C $b)$700°C
$c)$850°C $d)$ 820°C

**ANS: d) 820°C**

15.Stars twinkle due to,
a) refraction b) polarization
c)reflection d) total internal reflection

**ANS: (c) refraction**

## PART-B

**Answer any six questions and question no 19 is compulsory**

16 Define temperature coefficient of resistivity.

It is defined as the ratio of increase in resistivity per degree rise in temperature to its resistivity at $T_0$. Its unit is per °C

17.Why phosper-bronze is used as suspension in galvanometer?

Phosphor - bronze wire is used as the suspension wire because the couple per unit twist is very small. Due to it the galvanometer is very sensitive

18. State lenz law

Lenz's law states that the direction of the induced current is such that it always opposes the cause responsible for its production

19 The relative magnetic permeability of the medium is 2.5 and the relative electrical permittivity of the medium is 2.25. Compute the refractive index of the medium.

Solution

Dielectric constant (relative permittivity of the medium) = 2.5

Magnetic permeability, $\mu_r = 2.25$

$Refractive\ index\ of\ the\ medium, n = \sqrt{\varepsilon_r \mu_r} = \sqrt{2.5 \times 2.25} = \sqrt{5.625}$

$Refractive\ index\ of\ the\ medium, n = 2.37\ (no\ unit)$

20. What is displacement current?

Displacement current can be defined as 'the current which comes into play in the region in which the electric field and the electric flux are changing with time'

21.Distinguish between self -induction and mutual induction

**Self induction**

An electric current flowing through a coil will set up a magnetic field around it. Therefore, the magnetic flux of the magnetic field is linked with that coil itself. If this fluxis changed by changing the current, an emf is induced in that same coil

**Mutual induction**

When an electric current passing through a coil changes with time, an emf is induced in the neighbouring coil. This phenomenon is known as mutual induction and the emf induced is called mutually induced emf.

22. what is corona discharge?

- Smaller the radius of curvature, larger the charge density. Hence charges are accumulated at the sharp points.
- Due to this, the electric field near this sharp edge is very high and it ionized the surrounding air. The positive ions are repelled and negative ions are attracted towards the sharp edge.
- This reduces the total charge of the conductor near the sharp edge. This is called action of points or corona discharge

23. Write any two applications of the capacitor

- Capacitors are used in the ignition system of automobile engines to eliminate sparking.
- Capacitors are used to reduce power fluctuations in power supplies and to increase the efficiency of power transmission
- Flash capacitors are used in digital camera to take photographs
- During cardiac arrest, a device called heart defibrillator is used to give a sudden surge of a large amount of electrical energy to the patient' chest to retrieve the normal heart function. This defibrillator uses a capacitor of 175 µF charged to a high voltage of around 2000 V

24. What is the power of the lens?

The power 'P' of a lens is defined as the reciprocal of its focal length (f) in metres

$$P = \frac{1}{f\,(in\ m)} \quad = \quad (or)\ (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

The unit of power is diopter (D)

Power is positive for converging lens and negative for diverging lens

**PART C**

**Answer any six questions and question no 29 is compulsory**

25. List the properties of electric field lines

The electric field lines start from a positive charge and end at negative charges or at infinity.

For a positive point charge the electric field lines point radially outward and

for a negative point charge, the electric field lines point radially inward.

The electric field vector at a point in space is tangential to the electric field line at that point

The electric field lines are denser (more closer) in a region where the electric field has larger magnitude and less dense in a region where the electric field is of smaller magnitude

No two electric field lines intersect each other.

The number of electric field lines that eminent from the positive charge or end at a negative charge is directly proportional to the magnitude of the charges.

26.Write down the various forms of expression for power in electrical circuit

The electrical power P is the rate at which the electrical potential energy is delivered

$$P = \frac{du}{dt} \quad \frac{V(dQ)}{dt} - - - (1)$$

Since the electric curren $I = \frac{dQ}{dt}$ the equation( 1) becomes $P = VI$

By using ohm's law $V = IR$ power delivered to the resistance R is expressed in other form

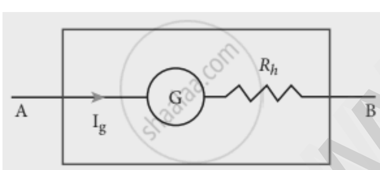
$$P = VI = IR \times I = I^2 R$$

$$P = IV = \frac{V}{R} \times V = \frac{V^2}{R}$$

27. Distinguish between coulomb force and gravitational force

| Coulomb force | Gravitational force |
|---|---|
| It acts between two charges | It acts between two masses |
| It can be attractive or repulsive | It is alwys attractive |
| It is always greater in magnitude | It is always lesser in magnitude |
| It depends on the nature of the medium | It is independent of the medium |
| If charges are in motion another force called Lorentz force come into play addition to coloumb force | Gravitational force is same whether two masses are at rest are in motion |

28.How is galvanometer is converted into a voltmeter




A voltmeter measures the potential difference (voltage) across two points in a circuit.

To convert a galvanometer into a voltmeter, we connect a high resistance (let's call it $\boldsymbol{R_h}$) in series with the galvanometer.

The scale is now calibrated in volt

the range of voltmeter depends on the values of the resistance $R_h$ connected in series

let $R_g$ be the resistance of the galvanometer

let $I_g$ be the current with which the galvanometer produces full scale deflection

the current in the electrical circuit is same as the current passing through the galvanometer

$$I = I_g$$

Since the galvanometer and high resistance are connected in series effective resistance in the circuit $R_V = R_g + R_h$

there fore from ohm's law $I_g = \frac{V}{R_g + R_h}$

$$R_g + R_h = \frac{V}{I_G}$$

$$R_h = \frac{V}{I_G} - R_g$$

Let $Rv$ be the resistance of voltmeter, then $R_v = R_g + R_h$

Here, $R_g < R_h < R_v$

Thus a voltmeter is a high resistance instrument, and it always connected in parallel to the circuit element.

An ideal voltmeter has infinite resistance.

29. The angle of minimum deviation for anequilateral prism is 37°. Find the refractiveindex of the material of the prism

given data

$A = 60^0$ $D = 37^0$ $n = ?$

$$n = \frac{\sin\left[\frac{A+D}{2}\right]}{\sin\left[\frac{A}{2}\right]}$$

$$n = \frac{\sin\left(\frac{60^0 + 37^0}{2}\right)}{\sin\left[\frac{60^0}{2}\right]}$$

$$n = \frac{\sin\left(\frac{97^0}{2}\right)}{\sin\left[\frac{60^0}{2}\right]}$$

$$n = \frac{\sin\ 48.5^0}{\sin\ 30^0}$$

$\sin 48.5^0 = 0.7489 \sin 30^0 = 0.5$

$$n = \frac{0.7489}{0.5}$$

$n = 1.5$

30. Find out the phase relation between voltage and current in a pure resistor circuit

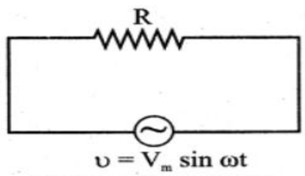



**Figure:** AC circuit with resistance

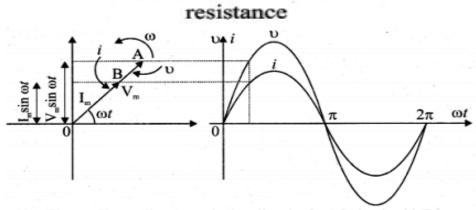



**Figure:** Phasor diagram and wave diagram for AC circuit with R

Consider a circuit containing a pure resistor of resistance R connected across an alternating voltage source.

The instantaneous value of the alternating voltage is given

$v = V_m \sin \omega t$------(1)

An alternating current $i$ flowing in the circuit due to this voltage, develops a potential drop across R and is given
$V_R = iR$--------(2)

Kirchoff's loop rule states that the algebraic sum of potential differences in a closed circuit is zero. For this resistive circuit,

$v - V_R = 0$

$v = V_R$

From (1)and(2)

$$\frac{V_m \sin \omega t}{R} = i$$

$i = I_m \sin \omega t$-----(3)

Where $\frac{V_m}{R} = I_m$the peak value of alternating current in the circuit.

From equations (1) and and (3), it is clear that the applied voltage and the current are in phase with each other in a resistive circuit.
It means that they reach their maxima and minima simultaneously.

31.Write a short notes on microwave and x-ray

Microwaves:
It is produced by special vacuum tubes such as klystron, magnetron and gunndiode.. The frequency range is $10^{11}$ Hz to $10^{9}$ Hz. It obeys reflection and polarization. It is used in radar system for aircraft navigation, speed of the vehicle, microwave oven for cooking and very long distance wireless communication through satellites.
X-rays:
It is produced when there is a sudden deceleration of high speed electrons at high-atomic number target, and also by electronic transitions among the innermost orbits of atoms. frequency range are $10^{21}$ Hz to $10^{16}$ Hz.
X-rays have more penetrating power than ultraviolet radiation
X-rays are used extensively in studying structures of inner atomic electron shells and crystal structures.
It is used in detecting fractures, diseased organs, formation of bones and stones, observing the progress of healing bones. Further, in a finished metal product, it is used to detect faults, cracks, flaws and holes.

32. What is total internal reflection? Write the two conditions for totalinternal reflection.

Total internal reflection:

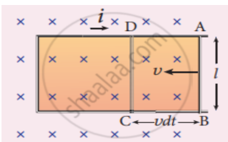
It is the phenomenon when a ray of light travelling in a denser medium is incident at the surface of a rarer medium such that the angle of incidence is greater than the critical angle for the pair of media the ray is totally reflected back into the denser medium.

The two conditions for total internal reflection to take place are,

(i) light must travel from denser to rarermedium,

(ii) angle of incidence in the denser medium must be greater than critical angle (i>ic)

33.How will you induce an emf by changing the area enclosed by the coil?



Consider a conducting rod of length l moving with a velocity υ towards left on a rectangular fixed metallic framework as shown in Figure

The whole arrangement is placed in a uniform magnetic field $\vec{B}$whose magnetic lines are perpendicularly directed into the plane of the paper.

As the rod moves from AB to DC in a time dt, the area enclosed by the loop and hence the magnetic flux through the loop decreases

$Change\ in\ magnetic\ flux in\ time\ dt\ is$

$d\emptyset_B = B \times change\ in\ area (dA)$

$d\emptyset_B = B \times Area\ ABCD$

$Since\ area\ ABCD = l(vdt)$

$d\emptyset_B = B \times\ l(vdt)$

$$\frac{d\emptyset_B}{dt} = B\ lv$$

As a result of change in flux, an emf is generated in the loop

$As\ a\ result\ of\ change\ in\ flux,$

$an\ emf\ is\ generated\ in\ the\ loop$

$$\varepsilon = \frac{d\emptyset_B}{dt}$$

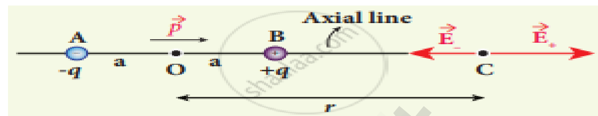
$\varepsilon = B\ lv$

This emf is known as motional emf . The direction of induced current is found to be clockwise from Fleming's right hand rule.

## PART D

## ANSWER ALL QUESTIONS

34 (A) Calculate the electric field due to a dipole on its axial line




Consider an electric dipole placed on the x-axis as shown in Figure . A point C is located at a distance of r from the midpoint O of the dipole on the axial line

The electric field at a point C due to +q is

$$\overrightarrow{E_+} = \frac{1}{4\pi\epsilon_0}\frac{q}{(r-a)^2}\quad along\ BC$$

Since the electric dipole moment vector $\vec{P}$ is from –q to +q and is directed along BC, the above equation is rewritten as

$$\overrightarrow{E_+} = \frac{1}{4\pi\epsilon_0}\frac{q}{(r-a)^2}\hat{P} - - - - - - (1)$$

where $\hat{P}$is the electric dipole moment unit vector from –q to +q.

The electric field at a point C due to –q is

$$\overrightarrow{E_-} = -\frac{1}{4\pi\epsilon_0}\frac{q}{(r+a)^2}\hat{P} - - - - - - (2)$$

Since +q is located closer to the point C than,$\overrightarrow{E_+}$ is stronger than $\overrightarrow{E_-}$Therefore, the length of the $\overrightarrow{E_+}$ vector is drawn larger than that of $\overrightarrow{E_-}$ vector

The total electric field at point C is

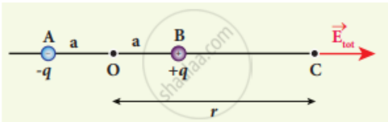
$$\overrightarrow{E_{tot}} = \overrightarrow{E_+} + \overrightarrow{E_-}$$

$$\overrightarrow{E_{tot}} = \frac{1}{4\pi\epsilon_0}\frac{q}{(r-a)^2}\hat{P} - \frac{1}{4\pi\epsilon_0}\frac{q}{(r+a)^2}\hat{P}$$

$$\overrightarrow{E_{tot}} = \frac{q}{4\pi\epsilon_0}\left(\frac{1}{(r-a)^2} - \frac{1}{(r+a)^2}\right)\hat{P}$$

$$\overrightarrow{E_{tot}} = \frac{q}{4\pi\epsilon_0}\frac{4ra}{(r^2-a^2)^2}\hat{P} - - - - - (3)$$

Note that the total electric field is along $\overrightarrow{E_+}$ since +q is closer to C than –q




If the point C is very far away from the dipole (r >> a). Then under this limit the term

$(r^2-a^2)^2 \approx r^4$ Substituting this into equation (3), we get

$$\overrightarrow{E_{tot}} = \frac{1}{4\pi\epsilon_0}\left(\frac{4aq}{r^3}\right)\hat{P} \quad (r >> a)$$

$$since\ \ 2aq\hat{P} = \vec{P}$$

$$\overrightarrow{E_{tot}} = \frac{1}{4\pi\epsilon_0}\left(\frac{2\vec{P}}{r^3}\right) \quad (r >> a)$$

If the point C is chosen on the left side of the dipole, the total electric field is still in the direction of $\vec{P}$.

34(B) .Define emission spectrum and explain the types of emission spectrum

Emission spectraum

When the light emitted directly from a source is examined with a spectrometer, the emission spectrum is obtained. Every source has its own characteristic emission spectrum.

The emission spectrum is of three types.

1. Continuous spectrum

2. Line spectrum

3. Band spectrum

1. Continuous spectrum

If the light from incandescent lamp (filament bulb) is allowed to pass through prism it splits up into seven colours. Thus, it consists of wavelengths containing all the visible colours ranging from violet to red

Examples: spectrum obtained from carbon arc and incandescent solids

2. Line spectrum

Suppose light from hot gas is allowed to pass through prism, line spectrum is observed Line spectra are also known as discontinuous spectra. The line spectra consists of sharp lines of definite wavelengths or frequencies.

Such spectra arise due to excited atoms of elements. These lines are the characteristics of the element and are different for different elements.

Examples: spectra of atomic hydrogen, helium, etc.

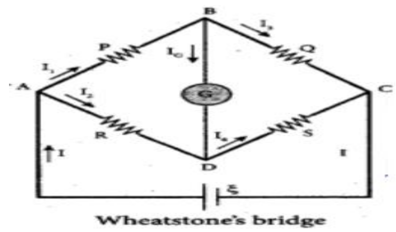
3. Band spectrum

Band spectrum consists of several number of very closely spaced spectral lines which overlap together forming specificbands which are separated by dark spaces. This spectrum has a sharp edge at one end and fades out at the other end.

Such spectra arise when the molecules are excited. Band spectrum is the characteristic of the molecule and hence the structure of the molecules can be studied using their band spectra.

Example: spectra of ammonia gas in the discharge tube etc

35 (A) .Obtain the condition for bridge balance in wheatstone bridge




An important application of Kirchhoff's rules is the Wheatstone's bridge. It is used to compare resistances and in determining the unknown resistance in electrical network.

The bridge consists of four resistances P, Q, R and S connected as shown in Figure

galvanometer G is connected between the points B and D.

The battery is connected between the points A and C.

The current through the galvanometer is $I_G$ and its resistance is G

Applying Kirchhoff's current rule to junction B and D respectively.

$I_1 - I_G - I_3 = 0 ----(1)$

$I_2 + I_G - I_4 = 0 ----(2)$

Applying Kirchhoff's voltage rule to loop ABDA,

$I_1P + I_GG - I_2R = 0 ------(3)$

$I_1P + I_3Q - I_4S - I_2R = 0 ------(4)$

When the points B and D are at the same potential, the bridge is said to be balanced.

As there is no potential difference between B and D,

no current flows through galvanometer ($I_G$ = 0).

Substituting IG = 0 in equation (1), (2) and (3), we get

$I_1 = I_3 ----(5)$

$I_2 = I_4 ----(6)$

$I_1P = I_2R ------(7)$

Substituting equation (5), (6) in (4), we get

$I_1P + I_1Q - I_2S - I_2R = 0$

$I_1(P+Q) - I_2(R+S) = 0$

$I_1(P+Q) = I_2(R+S) ----(8)$

Dividing equation (8) by equation (7), we get

$$\frac{I_1(P+Q)}{I_1P} = \frac{I_2(R+S)}{I_2R}$$

$$\frac{P+Q}{P} = \frac{R+S}{R}$$

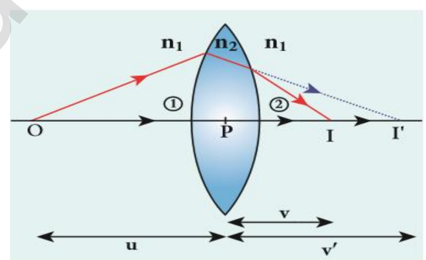
$$1 + \frac{Q}{P} = 1 + \frac{S}{R}$$

$$\frac{Q}{P} = \frac{S}{R}$$

$$\frac{P}{Q} = \frac{R}{S} ------(9)$$

This is the condition for bridge balance. Only under this condition, galvanometer shows null deflection

## 35 (B) Obtain lens maker's formula




A thin lens of refractive index $n_2$ is placed in a medium of refractive index $n_1$

Let $R_1$ and $R_2$ be radii of curvature of two spherical surfaces ① and ② respectively

Let P be pole of the lens and O be the Point object.

I' be the image to be formed due the refraction at the surface ①

I be the final image obtained due the refraction at the surface ②

We know that, equation for single spherical surface

$$\frac{n_2}{v} - \frac{n_1}{u} = \frac{(n_2 - n_1)}{R}$$

For refracting surface ①, the light goes from n1 to n2. Hence

$$\frac{n_2}{v'} - \frac{n_1}{u} = \frac{(n_2 - n_1)}{R_1} - - - - - - -(1)$$

For refracting surface ②, the light goes from n2 to n1. Hence

$$\frac{n_2}{v} - \frac{n_1}{v'} = \frac{(n_2 - n_1)}{R_2} - - - - - - -(2)$$

Adding equation (1) and (2), we get,

$$\frac{n_2}{v'} - \frac{n_1}{u} + \frac{n_2}{v} - \frac{n_1}{v'} = \frac{(n_2 - n_1)}{R_1} + \frac{(n_2 - n_1)}{R_2}$$

$$-\frac{n_1}{u} + \frac{n_2}{v} = (n_2 - n_1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$-\frac{1}{u} + \frac{1}{v} = \frac{(n_2 - n_1)}{n_1}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{v} - \frac{1}{u} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) - - - -(3)$$

If the object is at infinity, the image is formed at the focus of the lens. Thus, for u = ∞, v = f. Then equation(3) becomes

$$\frac{1}{f} - \frac{1}{\infty} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) - - - - - (4)$$

Here first medium is air and hence $n_1 = 1$ and let the refractive index of second medium be $n_2$=n. Therefore equation(4) becomes

$$\frac{1}{f} = (n - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) - - - -(5)$$

The above equation is called lens maker's formula

By comparing equation (3) and (4) we get

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

This equation is known as lens equation

36(A) . Explain the construction and working of transformer

**Principle**: The principle of transformer is the mutual induction between two coils. That is, when an electric current passing through a coil changes with time, an emf is induced in the neighbouring coil.

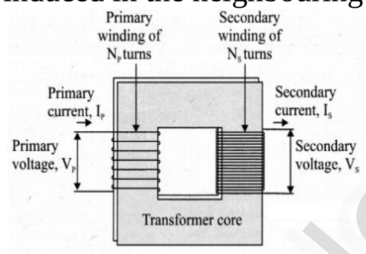



**Figure:** Construction of transformer

**Construction**:

In the simple construction of transformers, there are two coils of high mutual inductance wound over the same transformer core.

The core is generally laminated and is made up of a good magnetic material like silicon steel.

Coils are electrically insulated but magnetically linked via transformer core.

The coil across which alternating voltage is applied is called primary coil P

the coil from which output power is drawn out is called secondary coil S.

The assembled core and coils are kept in a container which is filled with suitable medium for better insulation and cooling purpose.

**Working:**

If the primary coil is connected to a source of alternating voltage, an alternating magnetic flux is set up in the laminated core.

If there is no magnetic flux leakage, then whole of magnetic flux linked with primary coil is also linked with secondary coil.

This means that rate at which magnetic flux changes through each turn is same for both primary and secondary coils.

As a result of flux change, emf is induced in both primary and secondary coils. The emf induced in the primary coil εp is almost equal and opposite to the applied voltage v p and is given by

$$v_p = \varepsilon_p = -N_p \frac{d\phi_B}{dt} - - - -(1)$$

The frequency of alternating magnetic flux in the core is same as the frequency of the applied voltage. Therefore, induced emf in secondary will also have same frequency as that of applied voltage. The emf induced in the secondary coil εs is given

$$\varepsilon_s = -N_s \frac{d\phi_B}{dt}$$

where Np and Ns are the number of turns in the primary and secondary coil, respectively. If the secondary circuit is open, then εs = vs where vs is the voltage across secondary coil.

$$v_s = \varepsilon_s = -N_s \frac{d\phi_B}{dt} ----(2)$$

From equations (1) and (2

$$\frac{v_s}{v_p} = \frac{N_s}{N_p} = K ----(3)$$

This constant K is known as voltage transformation ratio.

For an ideal transformer

$$input\ power\ v_p i_p = output\ power\ v_s i_s$$

where ip and is are the currents in the primary and secondary coil respectively.

Therefore,

$$\frac{v_s}{v_p} = \frac{N_s}{N_p} = \frac{i_p}{i_s} = K ----(4)$$

Equation (4) is written in terms of amplitude of corresponding quantities

$$\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s} = K ----(4)$$

i) If $N_s > N_p$ (K>1) $V_s > V_p$ *and* $I_s < I_p$

This is the case of step-up transformer in which voltage is increased and the corresponding current is decreased

ii) If $N_s < N_p$ (K<1) $V_s < V_p$ *and* $I_s > I_p$

This is step-down transformer where voltage is decreased and the current is increased

**Efficiency of a transformer:**

The efficiency η of a transformer is defined as the ratio of the useful output power to the input power.

$$\eta = \frac{out\ put\ power}{input\ power} \times 100\%$$

36 (B).Write down Maxwell equations in integral form

Maxwell equations - Integral form:

Electrodynamics can be summarized into four basic equations, known as Maxwell's equations.

Maxwell's equations completely explain the behaviour of charges, currents and properties of electric and magnetic fields.

These equations can be written in integral form

Equation - 1:

It is nothing but Gauss's law

It relates the net electric flux to net electric charge enclosed in a surface.

Mathematically, Gauss law is expressed as,

$$\oint \vec{E}\ .\overrightarrow{dA} = \frac{Q_{enclosed}}{\epsilon_0}$$

$\vec{E}$→ electric field, $Qclosed$ → charge enclosed

This equation is true for both discrete or continuous distribution of charges

It also indicates that the electric field lines start from positive change and terminate at negative charge.

The electric field lines do not form a continuous closed path (i.e.) isolated positive or negative charges can exist.

Equation - 2 :

It has no name. But this law is similar to Gauss law in electrostatics.

Hence this law can be called as Gauss's law in magnetism.

According to this law, the surface integral of magnetic field over a closed surface is zero.

Mathematically, this law can be expressed as,

$$\oint \vec{B}.\vec{dA} = 0$$

Here, $\vec{B}$ → magnetic field

This equation implies that the magnetic field lines form a continuous closed path. (i.e.) no isolated magnetic monopole exists

Equation - 3 :

This is Faraday's laws of electromagnetic induction.

This law relates electric field with the changing magnetic flux.

This equation implies that, the line integral of electric field around any closed path is equal to the rate of change of magnetic flux through the closed path bounded by the surface.

Mathematically it is expressed as,

$$\oint \vec{E}\,.\vec{dl} = \frac{d\phi_B}{dt}$$

Here, $\vec{E}$ → electric field

This equation implies that, the line integral of electric field around any closed path is equal to the rate of change of magnetic flux through the closed path bounded by the surface

Equation - 4 :

It is modified Ampere's circuital law and also called as Ampere - Maxwell's law.

This law relates the magnetic field around any closed path to the conduction current and displacement current through that path.

Mathematically it is expressed as

$$\oint \vec{B}\,.\vec{dl} = \mu_0 i_c + \mu_0\epsilon_0 \frac{d}{dt}\oint \vec{E}.\vec{dA}$$

where $\vec{B}$ is the magnetic field.

This equation shows that both conduction current and displacement current produce magnetic field

37(A) Explain Lorentz force

LORENTZ FORCE

When an electric charge q is kept at rest in a magnetic field, no force acts on it. At the same time, if the charge moves in the magnetic field, it experiences a force .

This force is known as magnetic force. It is given by the equation

$$\vec{F} = q(\vec{v} \times \vec{B})$$

if the charge is moving in both the electric and magnetic fields, the total force experienced by the charge is given by

$$\vec{F} = q(\vec{E} + \vec{v} \times \vec{B})$$

It is known as Lorentz force

When an electric charge 'q' moves with velocity $\vec{v}$ in the magnetic field, $\vec{B}$ it experiences

a force called Lorentz magnetic force $\vec{F}_m$

$$\vec{F_m} = q(\vec{v} \times \vec{B}) ------(1)$$

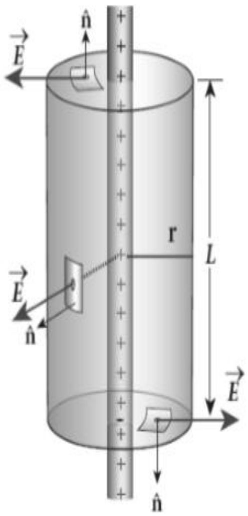
In magnitude $F_m = Bqv\sin\theta$ ------(2)

The equations (1) and (2) imply

1. $\vec{F_m}$ is directly proportional to the magnetic field $\vec{B}$
2. $\vec{F_m}$ is directly proportional to the velocity $\vec{v}$ of the moving charge
3. $\vec{F_m}$ is directly proportional to sine of the angle between the velocity and magnetic field
4. $\vec{F_m}$ is directly proportional to the magnitude of the charge q
5. The direction of . $\vec{F_m}$ is always perpendicular to $\vec{v}$ and $\vec{B}$ as $\vec{F_m}$ is the cross product of $\vec{v}$ and $\vec{B}$
6. The direction of $\vec{F_m}$ on negative charge is opposite to the direction of $\vec{F_m}$ on positive charge

7. If velocity $\vec{v}$ of the charge q is along magnetic field $\vec{B}$ then $\overrightarrow{F_m}$ *is zero*

37(B) . Obtain an expression for electric field due an infinitely long charged wire




Electric field due to infinitely long charged wire :

Consider an infinitely long straight wire of uniform linear charge density '$\lambda$'

Let 'P' be point at a distance 'r' from the wire.

Let 'E' be the electric field at 'P'

Consider a cylindrical Gaussian surface of length 'L' and radius 'r'

The electric flux through the top surface

( $\vec{E}$ *is perpendicular to* $\vec{A}$ )

$$\emptyset_{top} = \int \vec{E}.\overrightarrow{dA} = \int EdA\ \cos 90^{\circ} = 0$$

The electric flux through the bottom surface, ( $\vec{E}$ *is perpendicular to* $\vec{A}$ )

$$\emptyset_{bot} = \int \vec{E}.\overrightarrow{dA} = \int EdA\ \cos 90^{\circ} = 0$$

The electric flux through the curved surface,( $\vec{E}$ *is parallel to* $\vec{A}$ )

$$\emptyset_{curv} = \int \vec{E}.\overrightarrow{dA} = \int EdA\ \cos 0^{\circ}$$
$$= E\int dA$$

$$\int \boldsymbol{dA = 2\pi rL}$$

$$\emptyset_{curv} = E2\pi rL$$

Then the total electric flux through the Gaussian surface,

$$\emptyset_E = E2\pi rL$$

By Gauss law,

$$\emptyset_E = \frac{Q_{inside}}{\epsilon_0}$$

$$\because Qinside = \lambda\ L$$

$$\emptyset_E = \frac{\lambda L}{\epsilon_0}$$

$$E2\pi rL = \frac{\lambda L}{\epsilon_0}$$

$$E = \frac{\lambda L}{2\pi rL\epsilon_0}$$

$$E = \frac{1}{2\pi\epsilon_0}\frac{\lambda}{r}$$

In Vector notation

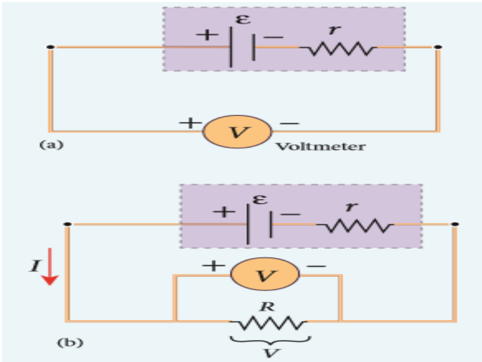
$$\vec{E} = \frac{\lambda}{2\pi\epsilon_0 r}\hat{r}$$

$$\vec{E} = \frac{1}{2\pi\epsilon_0}\frac{\lambda}{r}\hat{r}$$

Here $\hat{r}$ → unit vector perpendicular to the curved surface outwards.

If $\boldsymbol{\lambda} > 0$, then $\vec{E}$ points perpendicular outward $\hat{r}$ from the wire and if $\boldsymbol{\lambda} < 0$, then $\vec{E}$ points perpendicular inward $(-\hat{r})$

38(A) Explain the determination of the internal resistance of a cell using voltmeter




In reality, the battery is made of electrodes and electrolyte,

There is resistance to the flow of charges within the battery. This resistance is called internal resistance r.

The emf of the cell is measured by connecting high resistance voltmeter across it without connecting the external resistance R

This circuit may be considered as open, the voltmeter reading gives the emf (ξ) of the cell

Then external resistance is included in the circuit and current „I‟ is established in the circuit.

This circuit is then considered as close, the voltmeter reading gives the potential difference (V) across „R‟

By Ohm‟s law,

$V = IR - - - - - - - - (1)$

Due to internal resistance of the cell, the voltmeter reads the value "V" which is less than the emf „ξ' of the cell

It is because, certain amount of voltage (Ir) has dropped across the internal resistance „r‟.

Hence

$V = \xi - Ir - - - - - - - (2)$

$Ir = \xi - V$

$$r = \frac{\xi - V}{I}$$

$$r = \left(\frac{\xi - V}{V}\right) R$$

Since ξ, V and R are known, internal resistance „r‟ and total current „I‟ can be determined

The power delivered to the circuit is

$P = I\xi = I(V + Ir)$

$P = I(IR + Ir)$

$P = I^2R + I^2r$

where,

$I^2R \rightarrow$ power deliverd to R

$I^2r \rightarrow$ power deliverd to r

38(B)

i)Write Faraday's law of electromagnetic induction

**Faraday's first law**:

Whenever magnetic flux linked with a closed circuit changes, an emf is induced in the circuit.

The induced emf lasts so long as the change in magnetic flux continues.

**Faraday's second law**:

The magnitude of induced emf in a closed circuit is equal to time rate of change of magnetic flux linked with the circuit.

If magnetic flux linked with the coil changes by $d\Phi_B$ in time dt , then the induced emf is given by,

$$\varepsilon = -\frac{d\phi_B}{dt}$$

The negative sign in the above equation gives the direction of the induced current

If a coil consisting of 'N' turns, then

$$\varepsilon = -N\frac{d\phi_B}{dt}$$

$$\varepsilon = -\frac{d(N\phi_B)}{dt}$$

Here $N\Phi_B$ is called flux linkage

(ii) A straight metal wire crosses a magnetis field of flux 4 mWb in a time 0.4s .Find the magnitude of the emf induced in the wire.

Given data

$d\phi = 4m\,Wb = 4 \times 10^{-3}$

$dt = 0.4s$

Solution

$$Induced\ emf\ \varepsilon = \frac{d\phi}{dt}$$

$$Induced\ emf\ \varepsilon = \frac{4 \times 10^{-3}}{0.4s} = 10 \times 10^{-3}$$

$$Induced\ emf\ \varepsilon = 10mV$$

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