Section B

Short Question

(V)

ANSWER

Ohm's Law

This law was Presented by Germen Scientist Simon ohm in 1826.

Statement

The magnitude of the Current in a Conductor is Proportional to the applied voltage as long as the temperature of the Conductor is kept Constant.

Explanation

When a battery is Connected across a Conductor, an electric Current showed begins to flow through the Conductor. A German Physicist George Simon ohm Showed by experiment that the Current through the metallic Conductor is directly Proportional to the Potential difference across its ends. This fact is known as ohm' law.

Mathematically

$$I \propto V$$

$$I = \text{Const } V$$

$$I = KV$$

K is the Constant of proportionality and is known as Conductance of the Conductor i.e $K = 1/R$ thus

$$I = \left(\frac{1}{R}\right) V$$

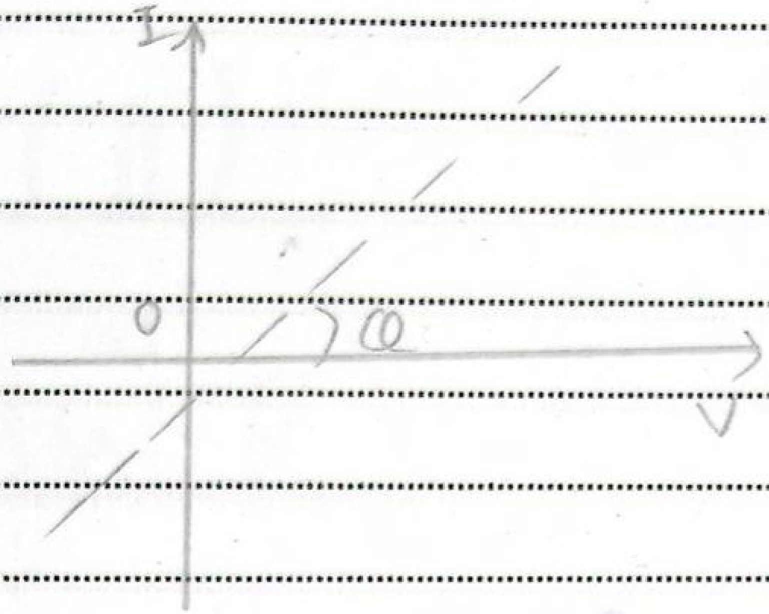
or

$$I = \frac{V}{R}$$

or

$$V = IR$$

Graphical Representation



(a) Metals.

For a Conductor that obeys ohm's law a graph of Current I as a function of voltage 'V' is a straight line passing through the origin as shown in figure.

Slope of the line in the Current verses voltage graph is given by

$$slope = \frac{I}{V}$$

From ohm's law we know that

$$\frac{I}{V} = \frac{1}{R}$$

$$\text{Slope} = \frac{I}{V} = \frac{1}{R}$$

Ohmic Conductor

A Conductor which obey ohm law called ohmic Conductor.

Example

Metals

Non-ohmic Conductor

A Conductor which Cannot obey ohm's law

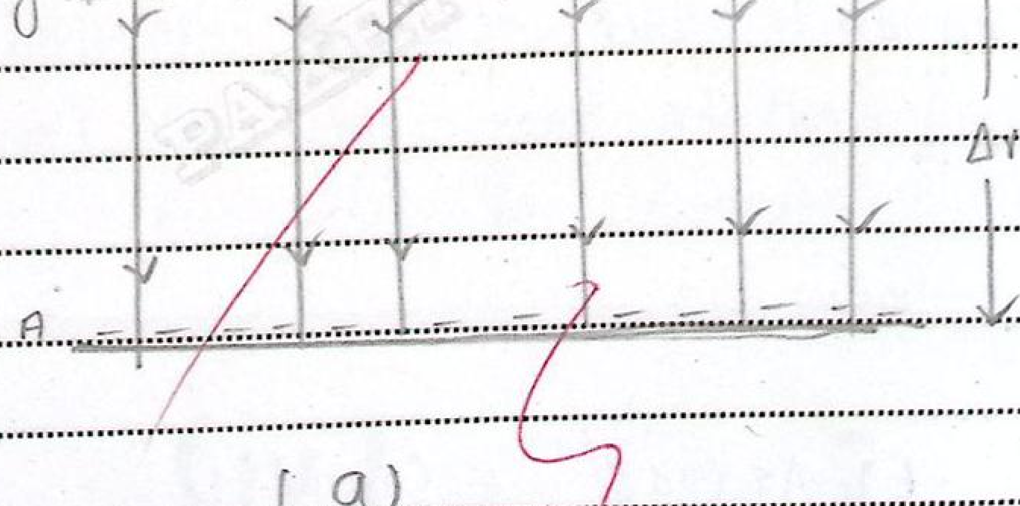
Example

Filament of bulb, Semi-Conductor

(II)

ANSWER

Relation between electric field and Potential gradient



(a)

Lets us Consider a uniform field, for which the lines of force are parallel

and equidistance from each other.
let A & B the two-points which are very close to each other so that the electric field intensity is almost Constant as shown in the figure (a)

The workdone in moving charge from plate A to B against the electric field is

work = $W_{AB} = \vec{F} \cdot \vec{\Delta r} = \vec{F} \cdot \vec{\Delta r} \cos\theta \longrightarrow (i)$

As the electric force acting on the charge is Eq_0 so in order to move the charge against electric field uniformly force equal in magnitude but opposite in direction mus applied on the charge i.e $F = -Eq_0$

Putting values in eq (i)

$W_{AB} = -Eq_0 \Delta r \cos 0^\circ \quad \because \cos 0^\circ = 1$

$W_{AB} = -Eq_0 \Delta r$

$\frac{W_{AB}}{q_0} = -E \Delta r$

$$\Delta V = -E\Delta r$$

$$\frac{\Delta V}{\Delta r} = -E$$

or

$$E = -\frac{\Delta V}{\Delta r}$$

The negative sign show that the change in potential decrease in the direction of electic field.

Unit of Potential Gradient

The unit of potential gradient is volt/meter. Thus we can say that electric field intensity can also be measured V/m.

(iv)

ANSWER

Volt

The term volt represents unit of potential difference and 1 volt is the potential difference when one joule of work is done in moving 1 Coulomb charge b/w the two plates against electric field.

Electron volt

Electron-volt is the unit of energy and 1 ev is the kinetic energy gained or lost by an electron when it moves through p.D of 1 volt.

Relation

The energy in electron-volts (ev) is equal to the voltage v in volts times the electric charge Q in elementary units (e).

$E_{(ev)} = V_{(v)} \times Q_{(e)}$

1 ev energy is equivalent to

$1ev = 1V \times 1e$

$1ev = 1 \times 1.6\times10^{-19}\,C$

$1ev = 1.6\times10^{-19}\,J$

Difference

volt & electron volt (ev) are two different physical quantitres.
Electric potential is a property associated with the field, while the energy is associated with the particle.

(I)

ANSWER

Given data

charge $= q_1 = 3\mu C = 3\times10^{-6} C$

distance $= 30\ cm = \frac{30}{100}\ m = 30\times10^{-2}\ m$

Required

Electric field $E = ?$

We know that

we know that

$E = \frac{kq}{r^2}$ $\quad k = 9\times10^{9}$

$E = \frac{(9\times10^{9})(3\times10^{-6}c)}{(30\times10^{-2})^2}$

$E = \frac{27\times10^{3}}{900\times10^{-4}}$

$E = 0.03\times10^{3}\times10^{4}$

$E = 0.03\times10^{7}$

$E = 3\times10^{5}\ N/C$

(IX)

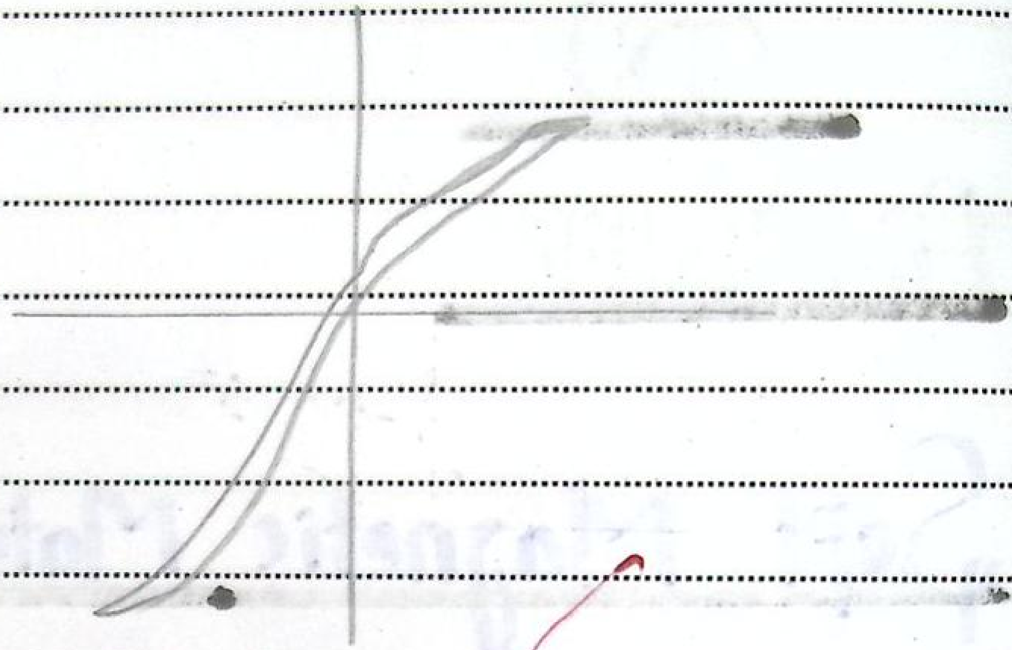
ANSWER

Soft Magnetic Materials

Materials with narrow magnetic hysteresis loop are easily magnetized and demagnetize & are called soft magnetic materials.

Explanation

Soft materials have narrow hysterisis loop thus they posses small amount of residual magnetism and to overcome less coercive force is required. Work must be done in claing hysterisis loop. It is equal to area enclosed by the loop & is dissipated in the form of heat.



Soft magnetic Materials

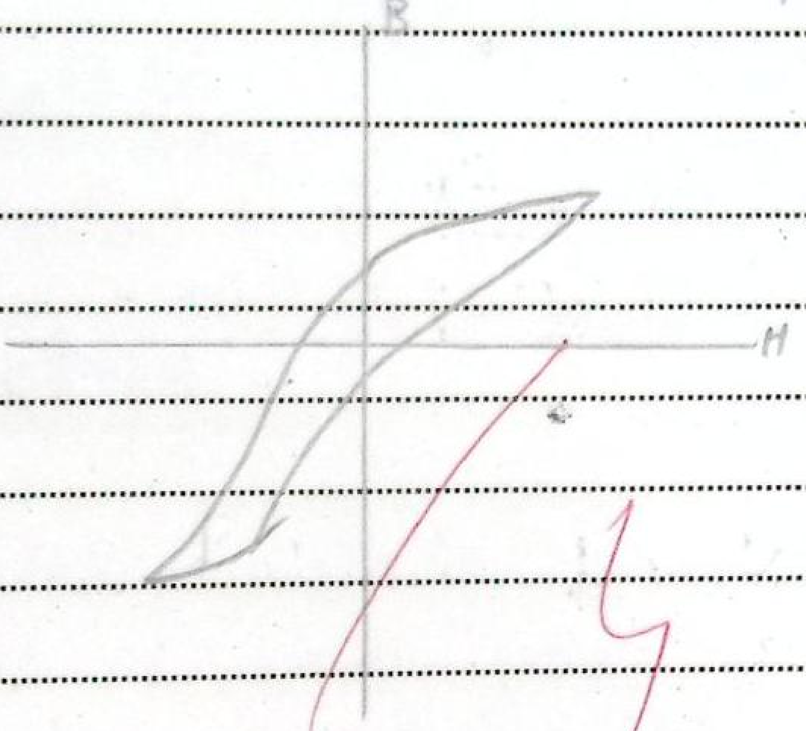
Hard Magnetic Materials

Materials with broad magnetic hysterisis loop are difficult to magnetize and demagnetize and are Called hard magnetic materials.

Explanation

Hard materials have fat hysterisis loop thus they posses large amount of residual magnetism & to overcome large Coercive force is required.

Thus once magnetized that the stay magnetized as substantial magnetic flux



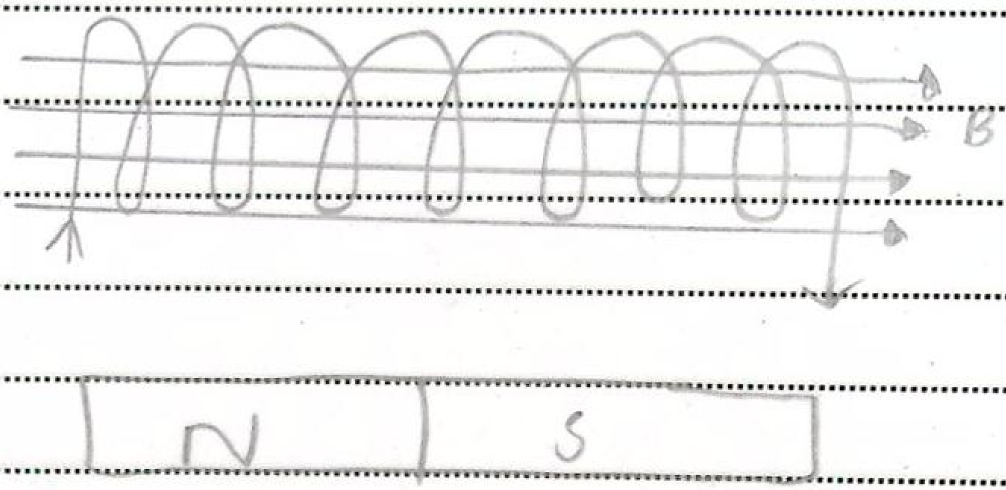
Hard magnetic materials

(VII)

ANSWER

A Current Carrying Coil behaves like a bar magnet.

Reason and Explanation



Consider a Coil is shown in the figure when Current passes through the Coil a uniform magnetic field is produced inside the turns of the Coil. The magnetic field lines originate from one side and ends at the other side. Now if we suspend the Coil freely, it will rotate and will settle down along North-South direction. As the earth magnetic field exists along North South direction so Current Carrying Coil behaves like a bar magnet.

(III)

ANSWER

Dielectric

An insulating material that becomes polarized in electric field.

Dipole

A pair of equal and opposite charges seperated by a small distance.

Dipole Moment ($\vec{p}$)

A vector quantity defined as $\vec{p} = q \cdot \vec{d}$ is charge $\vec{d}$ is the seperation.

Polarization

The aligment of electric

dipoles within a di-electric when placed in an electric field.

(VIII)

ANSWER

when we double the frequency, then the reactance of an inductor will also be double while that of Capacitor will half.

Reason and Explanation

Part (a)

In Case of an inductor, we have

$X_L = 2\pi f L \longrightarrow (i)$

when frequency becomes double

$X_L' = 2\pi f' L \Rightarrow X_L' = 2\pi (2f) L \longrightarrow (ii)$

$$X'_L = 2(2\pi f L) \longrightarrow (2)$$

putting eq (1) in eq (2)

$$X'_L = 2X_L$$

Eq (3) shows that the reactance of the inductor will becomes double if the frequency increases two times.

Part (b)

In Case of Capacitor

$$X_C = \frac{1}{2\pi f C} \longrightarrow (4)$$

Now when the frequency becomes double then we have $f' = 2f$ so eq (4) becomes

$$X'_C = \frac{1}{2\pi f' C} \Rightarrow X'C = \frac{1}{2\pi(2f)C}$$

$$\Rightarrow X'_C = \frac{1}{2}\left[\frac{1}{2\pi f C}\right] \longrightarrow (5)$$

Putting eq (4) in eq 5

$$X'_C = \frac{1}{2} X_C \longrightarrow 6$$

Eq (6) show that the reactance of the Capacitor become half if the frequency becomes double.

(XI)

ANSWER

β - Factor in Terms α - Factor

As $\beta = \frac{I_C}{I_B} \longrightarrow (i)$

Here $I_B = I_E - I_C$ so eq (i)

$$\Rightarrow B = \frac{I_C}{(I_E - I_C)} \longrightarrow (3)$$

$$B = \frac{I_C}{I_E\left(I - \frac{I_C}{I_E}\right)} \longrightarrow (3)$$

As $\frac{I_C}{I_E}$ = alpha factor = α so eq (3)

$$B = \frac{\alpha}{1-\alpha}$$

(XII)

ANSWER

For same De-Broglie wavelength the speed of electron will be greater than the speed of proton.

Reason and Explanation

We know that De-Broglie wavelength

$$\lambda = \frac{h}{mv} \longrightarrow (i)$$

For electron, eq (1) can be written

$$\lambda_e = \frac{h}{m_e V_e} \longrightarrow (2)$$

For Proton eq (1) can be written as

$$\lambda p = \frac{h}{m_p V_p} \longrightarrow (3)$$

For same De-Broglie wavelength

$$\lambda e = \lambda p = \frac{h}{m_e V_e} = \frac{h}{m_p V_p}$$

$$m_e V_e = m_p V_p = V_e = \left(\frac{m_p}{m}\right) V_p \longrightarrow (4)$$

A mass of of Proton is greater than mass of electron

$$m_p > m_e = \frac{m_p}{m_e} > 1$$

So eq (4) become

$$V_e > V_p$$

This for same De-Broglie wavelength the speed of electron will be greater than the speed of Proton.

Section C

Comprehensive Question

Turn Page

QUESTION 3

Part (a)

Alternating Current (AC) Generator

Definition

The device which Convert mechanical energy into electrical energy in the form in which the flow of electric charges periodically reverse direction.

Working Principle

The working of an electric generator is based on Faraday's law of electromagnetic induction.

Construction

It Consist of Coil, two slip rings and two Carbon brushes. When Coil rotat the electromotive force is induced. The Current flow through the external Circuit by slip ring. Which are ma of Copper. A_1 Connected with the side EF of the C

Working

When the side CD move up-wards Fleming's Right hand Rules show that the direction of Current is from C to D and E to F. Thus the Current (output) enters the Circuit at B_1 and leaves at B_2. Half revolution later EF will be in the position previously occupied by CD and direction is reversed. i.e it is form F to E and D to C. The Current now enters the Circuit at B_2 and leaves at B_1. Thus the direction of induced electromotive force and the Current changes every half revolution.

Part (b)

Given

Initial Current = I_i = 5A

Final Current = I_f = 0A

Change in time = Δt = 0.1s

Change in Current = $\Delta I = I_f - I_i = (0-5) = -5A$

Self induced emf = $\mathcal{E}$ = 200 volts

Required

Self inductance = ?

We know that

$$\mathcal{E} = -L\frac{\Delta I}{\Delta t}$$

$$L = \frac{-\mathcal{E}\Delta t}{\Delta I}$$

$$L = \frac{-(200)\times(0.1)}{-5}$$

$$L = 4\,H$$

QUESTION 5

Part b

9

Mass of 6.02×10^{26} atoms of ${}_6C^{12}$ = 12 kg

Mass of 1 atom of ${}_6C^{12} = \frac{12}{6.02\times10^{26}}$ kg

Mass of $\frac{1}{12}$th atom of ${}_6C^{12} = \frac{1}{12}\times\frac{12}{6.02\times10^{26}}$ kg

$1U = 1\ a.m.u = 1.66\times10^{-27}$ kg

Unit of energy in term of amu

In atomic and nuclear physics, the mass is often expressed in term of energy. So by Einstien energy mass equivalance eq. $E = mc^2$

$E = (1.66\times10^{-27}\,kg)(3\times10^{8}\,m/s)^2 = 1.49\times10^{-10}\,J$

Since $1\,eV = 1.6\times10^{-19}\,J \Rightarrow 1\,J = \frac{1}{1.60\times10^{-19}\,eV}$

$E = 1.49\times10^{-10}\times\frac{1}{1.60\times10^{-19}}\,eV = 931$

So 1 amu or $1U$ = 931 MeV

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CONTINUATION SHEET

Fic. No. 2

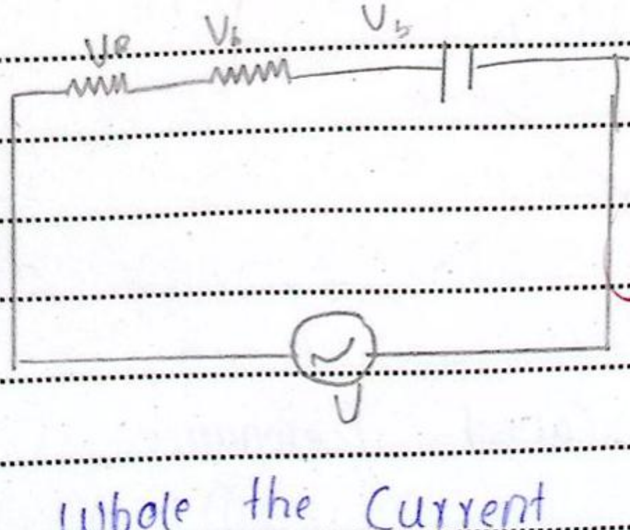
102

(صرف بورڈ کے استعمال کیلئے) اُمیدوار یہاں کچھ نہ لکھیں

Part(a)

RLC SERIES AC Circuit

Many ac Circuits used in practical electronic involve resistor, induce and capacitor. Fig show a RLC Series Circuit which is excited b Sinusoida ac voltage Source of angular frequency.



whole the Current that flow and phase difference Source and Current

$V^2 = V_x + (V_1 - V_2)^2$

But $V_R = I R$; $V = X_L$ & $V_c = I X_c$

$V^2 = I^2 R^2 + (I X_L - X_c)^2$

$\therefore V = I\sqrt{R^2 + (X_L - X_c)^2}$

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

$\tan\theta = \dfrac{V_L - V_c}{V} = \dfrac{IR}{IZ} = \dfrac{R}{Z}$

$\langle P \rangle = I_{rms} V_{rms} \cos\theta$

$I = \dfrac{V_{rms}}{Z} = \dfrac{V}{\sqrt{R^2 + (X_L - X_C)^2}}$

$X_L = X_C \quad 2\pi f L = \dfrac{1}{2\pi f C}$

$f^2 = \dfrac{1}{4\pi^2 LC}$

$f_0 = \dfrac{1}{2\pi\sqrt{LC}}$

This frequency is Called Resonance frequency.

4+1

QUESTION 6

Part a

Consider a Parallel Capacitor. Let the medium between the plate is air and d be the distance b/w the plates

$$Q = CV$$

$$C = \frac{Q}{V} \longrightarrow (1)$$

we know that

$$V = Ed \longrightarrow (2)$$

putting eq (2) in eq (1)

$$C = \frac{Q}{Ed} \longrightarrow (3)$$

For oppositely charge plate parallel is

$$E = \frac{\sigma}{\varepsilon_0} \longrightarrow (4)$$

$$C = \frac{Q\varepsilon_0}{\sigma d}$$

$$\sigma = \frac{Q}{}$$

$$Q = \sigma A$$

$$C = \frac{A\varepsilon_0}{d} \longrightarrow (7)$$

When medium is Di-electric

$$C' = \frac{A\varepsilon}{d} \longrightarrow 8$$

Eq 8 represents the capacitance of parallel plate capacitor having di-electric medium between their plates.

Compare C & C

$$\varepsilon_r = \frac{\varepsilon}{\varepsilon_0} \Rightarrow \varepsilon = \varepsilon_r \varepsilon_0$$

$$C' = \frac{A\varepsilon_r \varepsilon_0}{d}$$

$$C' = \varepsilon_r \left[\frac{A\varepsilon_0}{d}\right] \longrightarrow (10)$$

put eq 7 in eq 10

$$C' = \varepsilon_r C \longrightarrow (11)$$

4.5

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CONTINUATION SHEET

Fic. No. 1024

(صرف بورڈ کے استعمال کیلئے) اُمیدوار یہاں کچھ نہ لکھیں

As for dielectric medium we have $\varepsilon_r > 1$ So eq (ii) Can be written as
$C' > C$

Part b

Wheatstone Bridge

A simple circuit which is used to measure an unknown resistance precisely and accurately is called wheatstone bridge.

Construction

wheatstone bridge was designed by british professor charles wheatstone (1802) 1875.

Working Principle

The working of wheatstone bridge is based on balancing of bridge. The resistance are arranged in such a way that there is no current present between B and D and galvanometer show zero deflection.

Working

The resistance of P and Q are fixed whereas R can be varied, to determine the unknown resistance X. When the key closed the current is divided between the branch AB and AD as I_1 and I_2 respectively and galvanometer G will show deflection. This means that voltage drops across AB and AD is equal.

Since under Balanced Condition the potential drop across AB is equal potential across

AD.

$I_1 P = I_2 R \longrightarrow (1)$

$I_1 Q = I_2 X \longrightarrow (11)$

Dividing Eq 2 by Eq (1)

$$\frac{\cancel{I_1} Q}{\cancel{I_1} P} = \frac{\cancel{I_2} X}{\cancel{I_2} R}$$

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

$$X = \frac{RQ}{P}$$