SECTION (B)

Q NO: 02

(PART ii)

PROOF OF $E = -\Delta V/\delta$

POTENTIAL GRADIENT:

Potential gradient is defined as the ratio of change potential difference per unit displacement.

PROOF:-

Suppose a test charge is subjected to the electric field which is in the direction from positive to the negative plate. The unit test positive charge will move in the direction of electric field. Now work must be done to prevent that charge to move in the direction of electric field. The workdone is given by;

$$W = F \Delta x \quad - (i)$$

as

$$F = q_0 E.$$

then

$$W = q_0 E \Delta x \quad - (ii)$$

Also the workdone is given by;

$$W = -q_0 \Delta V \quad - (iii')$$

comparing (iii) and (iii') we get;

$$q_0 E \Delta x = -q_0 \Delta V$$

$$E = -\frac{\Delta V}{\Delta x} \quad - (iv)$$

eq (iv) represents the potential gradient.

(PART V)

OHM'S LAW:-

The Ohm's law was proposed by George Ohm in 1928 which states that the applied voltage (V) is directly proportional to the current (I).

$V \propto I \Rightarrow V = IR$

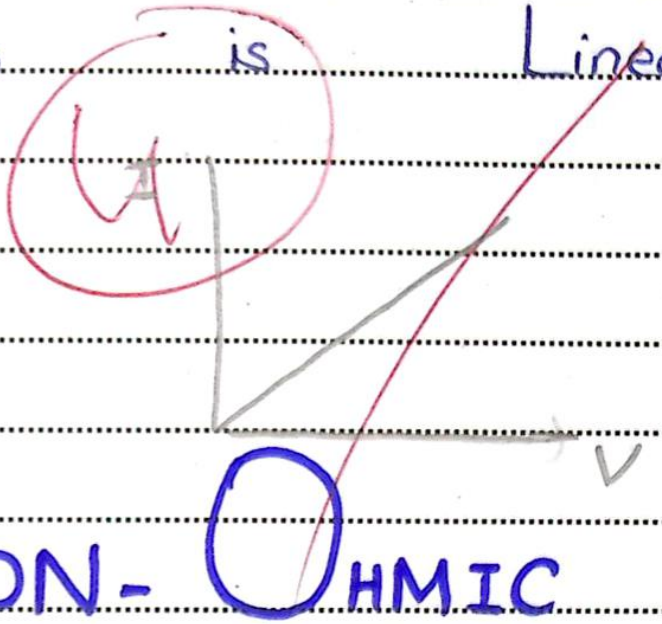
where R is the resistance.

OHMIC CONDUCTORS:-

These are the conductors which obeys Ohm law and current is in direct proportion with the applied voltage.

Examples:- All the metals are examples of Ohmic conductors.

GRAPH:- The IV graph obtained for these conductor is Linear.



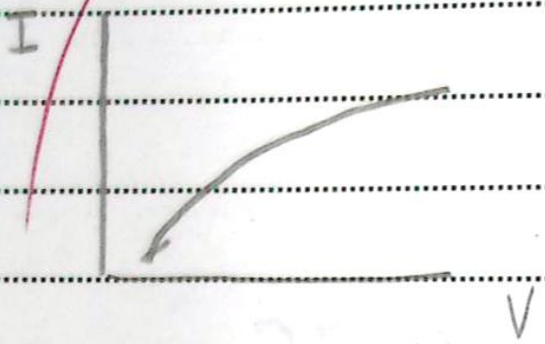
NON-OHMIC CONDUCTORS:-

In these conductors the Ohm's law is not obeyed and current is not in direct proportion with voltage.

Examples:- Examples are semi-conductors, transistors and filaments.

GRAPH:-

The IV graph for these conductors is not linear.



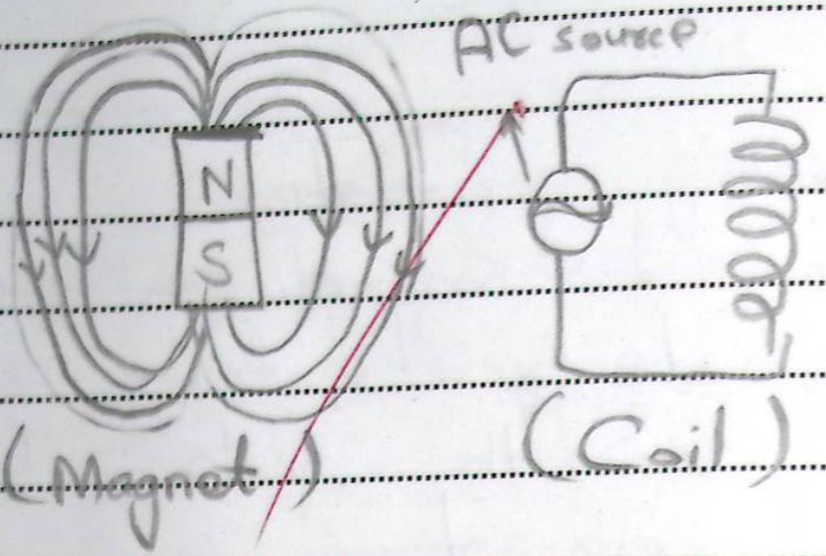
(Vii)

Current carrying coil behaves like a bar magnet.

EXPLANATION:-

A permanent magnet

is a substance which creates it's own magnetic field originated from North to South - pole. When a current is passed through a coil it also creates it's own North and South pole which creates it's magnetic field thus it behaves like a proper magnet when the current is pass through it.



(Viii)

Part - I

INDUCTIVE REACTANCE:-

We know that inductive reactance is given by;

$$X_L = \omega L \quad \text{— iii}$$

as $\omega = 2\pi f$

then;

$$X_L = 2\pi f L$$

if we double the frequency the $f' = 2f$ so we get;

$$X_L' = 2\pi(2f)L$$
$$X_L' = 2(2\pi f L)$$
$$X_L' = 2(X_L) \quad \text{— (iii)}$$

eq (iii) shows by doubling the frequency the inductive reactance increases by factor of 2.

Part - I

CAPICITIVE REACTANCE

We know capacitive reactance is given by;

$$X_c = \frac{1}{\omega C} \quad \text{— (i)}$$

as $\omega = 2\pi f$

then;

$$X_c = \frac{1}{2\pi f C}$$

if we put $f' = 2f$

then;

$$X_c' = \frac{1}{2\pi(2f)C} = \frac{1}{2}\left(\frac{1}{2\pi f C}\right)$$

$$X_c' = \frac{1}{2}X_c \quad \text{— (ii)}$$

eq (ii) represents that capacitive reactance decreases by factor 1/2 by doubling the frequency.

(ix)

Soft Magnetic materials	Hard Magnetic materials
i) The substances which can easily be magnetized and de-magnetized are called soft magnetic materials.	ii) The substances which cannot be easily magnetized and de-magnetized are called hard magnetic materials.
ii) Hysteresis loop is narrowed for these substances.	(iii) Hysteresis loop is fat.
iii) Residual magnetism is low.	(iii) Residual magnetism is high.

iv) Coercive forces are small	(iv) Coercive forces are large.
v) Hysterisis loss is low.	(v) Hysterisis loss is high.
vi) e.g Nickel, Iron	(vi) e.g Cunefi II, Steel.

(X)

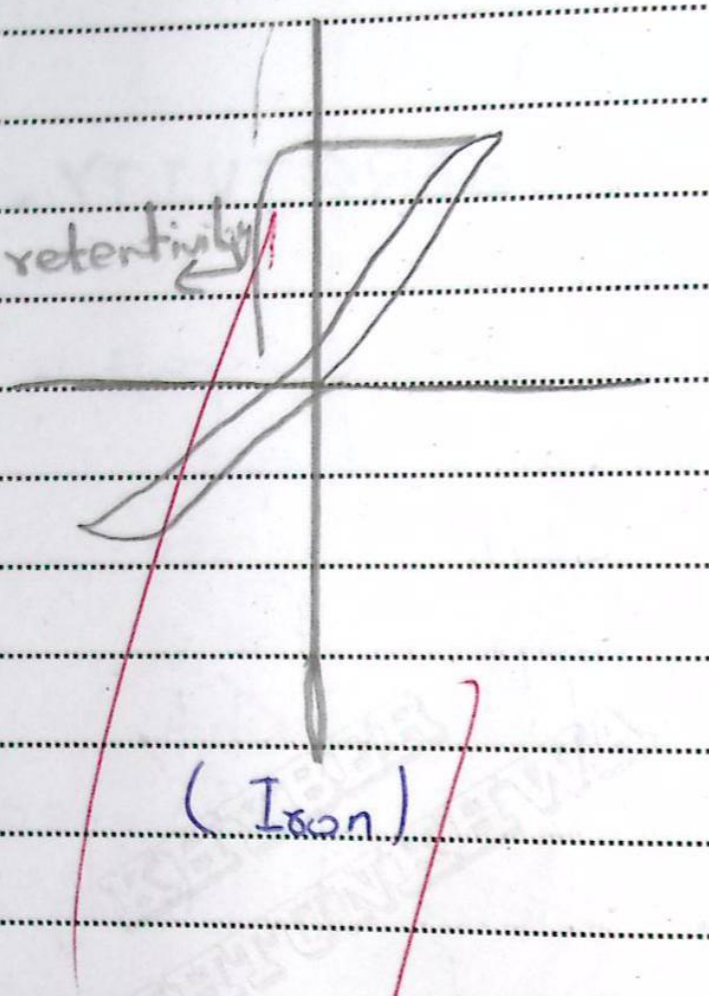
COERCIVE FORCE:-

The magnetic force which brings the retentivity to zero is called coercive force.

STEEL HAS LARGE COERCIVITY:-

If we compare the Hysterisis loops then we can see that the loop for steel is fat while for iron is narrowed. The loop shows that iron has greater magnetic retentivity but the coercive force is larger for steel.

GRAPH:-



(XII)

If the electron and proton has same wavelengths, then the speed of electron will be greater.

PROOF:-

The de-Broglie wavelength is given by;

$$\lambda = \frac{h}{mv} \quad \text{— (i)}$$

$$v = \frac{h}{m\lambda} \quad \text{— (ii)}$$

$$v \propto \frac{1}{m} \quad \text{— (iii)}$$

eq (ii) and (iii) shows

that for higher mass there will be less speed and vice versa.
Since, proton is 1837 time heavier than electron so proton will have less speed while the speed of electron will be higher.

(i)

GIVEN:-

Charge = $3\mu C = 3 \times 10^{-6} C$

Distance = $x = 30cm = 0.3m$

TO FIND:-

E = ?

SOL:-

As we know that,

$$E = \frac{kq}{r^2} \quad \text{— (i)}$$

$$E = \frac{9 \times 10^9 \times 3 \times 10^{-6}}{(0.3)^2}$$

$$E = \frac{27 \times 10^3}{(0.3)^2} = 3.0 \times 10^4 \text{ N/C}$$

(PART (ii))

VOLT:-

Volt is the unit of electric potential and is defined as when one joule work is done on 1 coulumb charge in an electric field.

ELECTRON - VOLT:-

The energy gain or loss by an electron in an electric field is called electron volt. It is the unit of energy.

RELATION:-

As we know;

$$1eV = e \times V \quad \text{---(i)}$$

as $e = 1.602 \times 10^{-19} C$

then;

$$1eV = 1.602 \times 10^{-19} J$$

DIFFERENCE:-

The difference between them is that Volt is unit of potential difference while eV is unit of energy.

(Xiii)

PAIR PRODUCTION:-

It is the phenomena in which photon hits a nucleus and two particles called electron and positron is released.

EXPLANATION:-

It is in resemblance with Einstein equation $E = mc^2$ in which energy is converted into the mass. The law of charge, momentum and energy should be obeyed therefore a particle called positron is released with same mass and charge but it is positive The equation showing pair production phenomena is given below.

$$hf = 2mc^2 + K.E_{(e)} + K.E_{(e)}$$

In above equation hf is energy of photon while $K.E_{(e)}$ and $K.E_{(e)}$

are the energy of electron and positron respectively.

SECTION (C)

Q NO: 06

a) Capacitance of Parallel Plate Capacitor:-

Consider a capacitor of

capacitance is connected to the battery. The plate which is connected to positive terminal is at potential difference +V and the one with negative plate is −V then we can write

$$E = \frac{V - V}{d} = \frac{\Delta V}{d} \quad \text{— (i)}$$

in eq (i) d is the separation between plates. If we consider the plates as gaussian surface and apply Gauss's law then we can write;

$$E = \frac{\sigma}{\varepsilon_0} \quad \text{— (ii)}$$

in eq (ii) "σ" is the charge density of plates while "ε_0" is the permitti-

vity of free space.

Now by definition of charge density

$$\sigma = \frac{Q}{A} \quad \text{— (iii)}$$

putting (ii) in (iii)

$$E = \frac{Q}{A\varepsilon} \quad \text{— (iv)}$$

comparing iii and (iv)

$$\frac{V}{d} = \frac{Q}{A\varepsilon}$$

by re-arranging

$$\frac{Q}{V} = \frac{A\varepsilon}{d} \quad \text{— (v)}$$

as $\frac{Q}{V} = C$ then;

$$C = \frac{A\varepsilon}{d} \quad \text{— (vii)}$$

we also have; $\varepsilon = \varepsilon_0 \varepsilon_r$

then eq vii becomes;

$$C = \frac{A \varepsilon_0 \varepsilon_r}{d} \quad \text{(viii)}$$

eq viii represents the capacitance of a capacitor of parallel plates showing it's dependence on area of plates, di-electric constant $\varepsilon_0 \varepsilon_r$ and separation between plates.

(b)

WHEATSTONE BRIDGE:-

It is a device which is used to know the value of unknown resistance.

WORKING PRINCIPLE:-

It is based on the principle of balancing the potential drop.

CONSTRUCTION:-

It is made of two known fixed resistances P and Q, there is a known and variable resistance R and unknown

resistance X. The junction
AC is connected to
Galvanometer while junction
BD is connected to
battery.

WORKING:-

When the
switch is turned ON
the Galvanometer shows
deflection. The variable
resistor is adjusted in
such a way that
galvanometer show zero
deflection and this
point is called balanced
point. Suppose current I_1
and I_2 passes through
P and R then these
voltage drop must be
equal because there is
no deflection in galvano

meter. So,

$I_1 P = I_2 R$ — (i)

then voltage drop across Q and X is

$I_1 Q = I_2 X$ — (ii)

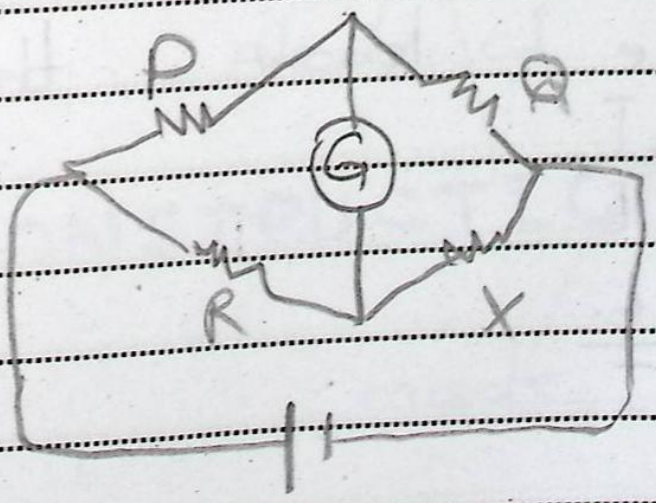
dividing (ii) by (i) we get,

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

$$XQ = PR$$

$$X = \frac{PR}{Q} \quad \text{— (iii)}$$

through eqn (iii) unknown resistance can be found and calculated.



Q NO:03

8

(b)

Given:-

$\Delta I = 0 - 5 = -5$
$\Delta t = 0.1s$
$\mathcal{E} = 200V$

To find:-

Self Inductance $= L = ?$

Sol:-

We know that;

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

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

$$L = 200 \times \frac{0.1}{5} = \frac{20}{5}$$

L = 4 Henry

(a)

AC GENERATOR:-

It is device which converts mechanical energy into electrical energy.

CONSTRUCTION:-

It is made of recta-

gular coil CDEF placed between magnetic field which causes the induction of current in it. When the coil CD side moves upward the direction of current in coil from C to D and E to F. When the side EF comes upward then the direction is from D to C and F to E showing that at each half rotation the direction of current changes and produce Voltage time varying wave. The number of cycles per second is called frequency.

$$f = \frac{N}{t}$$

Now we examine the value of flux at different points where the e.m.f changes.

Now we know,

$$\varepsilon = \frac{N \Delta \Phi \cos\theta}{\Delta t}$$

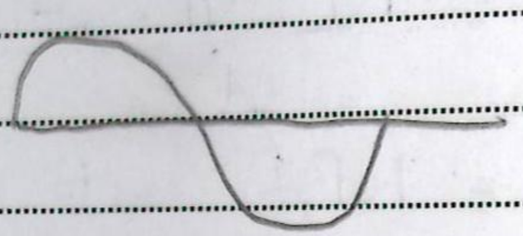
$$\varepsilon = \frac{NBA \cos\theta}{\Delta t}$$

as $\frac{\cos\theta}{\Delta t} = \omega \sin\omega t$

then;

$$\varepsilon = NBA\omega \sin\omega t$$ ... (i)

The above equation shows it's dependence on the rotational movement.



from the above wave we can conclude.

i) At 0° = no e.m.f

ii) At 90° = e.m.f is present

iii) At 180° = no e.m.f

iv) At 270° = e.m.f maximu

Q NO: 04

(a)

6

BOHR'S MODEL:-

The following are the main postulates of Bohr's model.

1) Electron revolves around the nucleus in a circular path. This centripetal force is provided by Coulomb's force.

2) The electron can only reside in specific path for which the momentum is of integral multiple.

3) When electron jumps from higher to lower shell it radiates emission of energy hf.

FOR RADIUS:-

When electron moves in a circular path around nucleus then the the centripetal force is provided by Coulumb's force.

$$\frac{mv^2}{r} = k\frac{q^2}{r^2}$$

$$mv^2 = k\frac{q^2}{r^2} \times r \quad \text{---(i)}$$

we know

$$L = \frac{nh}{2\pi} = mv_0 = \frac{nh}{2\pi}$$

$$v = \frac{nh}{2\pi v_0} \quad \text{— (iii)}$$

putting (iii) in (i)

$$m\left(\frac{nh}{2\pi v_0}\right)^2 = \frac{kq^2}{x}$$

$$m\,\frac{n^2h^2}{4\pi^2 v_0^2 x} = \frac{kq^2}{x}$$

$$kq^2 4\pi^2 v^2 x = mn^2h^2$$

$$x = \frac{n^2 mh^2}{kq^2 4\pi^2 v^2} \quad \text{— (iv)}$$

in eq (iii) $mh^2 / kq^2 4\pi^2 v^2$ is constant and is equal to $x_0 = 0.592$

$$x = n^2 x_0$$

(b)

GIVEN

$n = 4$

TO FIND:-

$\lambda = ?$

SOL:-

$$\frac{1}{\lambda} = R_H \left(\frac{1}{p^2} - \frac{1}{n^2} \right)$$

$$\frac{1}{\lambda} = R_H \left(\frac{1}{1^2} - \frac{1}{4^2} \right)$$

$$\frac{1}{\lambda} = 1.097 \times 10^7 \left(\frac{1}{1} - \frac{1}{16} \right) \quad \lambda = 1.028 \times 10^{-7} \text{ m}$$