SECTION ★ B

QUESTION

ANSWER THE FOLLOWING QUESTIONS:

SHORT ANSWERS

(i)

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

Consider a point charge (test charge) placed in uniform electric field. Work has to be done against the electric field in moving it to A from B.

Work done

$$W = -F \Delta r \quad -(1)$$

Negative sign indicates that work is done against Electric field. We know

$$E = \frac{F}{q}$$

$$F = Eq \quad -(2)$$

We know that the potential difference is given

$$\Delta V = \frac{W}{q}$$

$$W = -\Delta V q \quad -(3)$$

Put equation (2) and (3) in eq (1)

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

Proved.

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

ii

OHM'S LAW:-

statement :-

Magnitude of the voltage is directly proportional to the magnitude of the current at constant temp.

$I \propto V$

$\frac{1}{R}$ is the constant (resistance constant)

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

OHMIC SUBSTANCES:-

Those devices which follow the ohm's law are called ohmic devices or ohmic conductor.

e.g All metals

NON OHMIC SUBSTANCES:-

Those devices which does not follow the ohm's law are known as non ohmic substances.

OHMIC SUBSTANCES

- Those substances which follow the ohm's law.
- Current is directly proportional to voltage.
- When we increase the current the voltage increase

Example

All metals

NON OHMIC SUBSTANCES

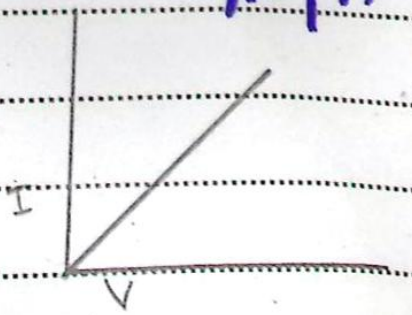
Those substances which donot follow ohm's Law.

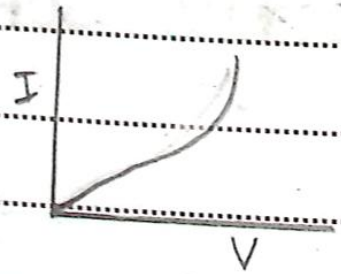
Current is not directly proportional to voltage.

When we increase the voltage the current donot Increarly it heat's up and offers resistance

Tungsten Filament

Graph





iii

Current Carrying Coil like Bar Magnet.

The current carrying behaves like a bar magnet when its magnetic field is same of the bar magnet.

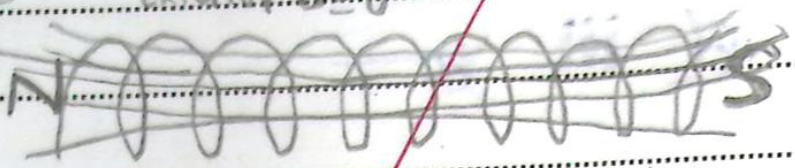
Explanation.

Coil is a loop of wire which has turns in it. when the turns of coil are tightly packed and length is greater than radius then it develops the strong magnetic field inside the coil which is same of the bar magnet as it develops North and south pole in it.

When the current is passed through the coil it develops magnetic field as of the bar magnet.

current carrying coil

Magnetic field



Magnetic field Behave like Bar Magnet.

Conclusion:

current carrying coil behaves like bar magnet because of their magnetic fields are same.

iv

Doubling the frequency affect the inductive reactance and capacitive reactance.

INDUCTIVE REACTANCE:

$\Rightarrow X_L = \omega L$

$(\omega = 2\pi f)$

$\Rightarrow X_L = 2\pi f L$

$\Rightarrow$ Double the frequency

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

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

$\boxed{X_L = 2X_L}$

So when we increase the frequency the inductive reactance doubles.

CAPACITIVE REACTANCE:

$\Rightarrow X_C = \frac{1}{\omega C}$

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

$\Rightarrow$ Double the frequency.

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

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

$$\Rightarrow \boxed{X_C = \frac{1}{2X_C}}$$

When the frequency double capacitive reactance decreases.

CONCLUSION:

So when we double the frequency the inductive reactance increases and the capacitive reactance decreases.

V

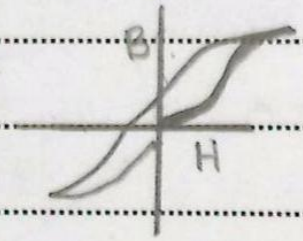
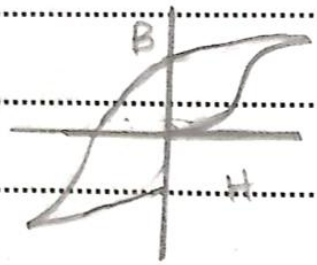
SOFT MAGNETIC MATERIAL:.

Soft magnetic materials are those which can be easily magnetize and de-magnetize.
It has narrow hysteresis loop.
It has less residual magnetic flux.

HARD MAGNETIC MATERIAL:.

Hard Magnetic Materials are those which cannot be easily magnetize and demagnetize.
It has fat hysteresis loop.
It has larger residual magnetic flux.

SOFT MAGNET	HARD MAGNET.
EASILY MAGNETIZE AND DE MAGNETIZE.	
Magnetic Material that can be easily magnetize and de-magnetize.	Magnetic Material which cannot be easily magnetize and de magnetize.

It has narrow hysteresis loop	It has fat hysteresis loop.
Residual Magnetic Flux.	
It has less residual magnetic flux.	It has larger residual magnetic flux
Permanent Magnet	
It cannot act as the permanent magnet.	It act as the permanent magnet.
Hysteresis Loop	
	
Example	
Iron, nickel copper.	steel, conife

vi

COERCIVE FORCE OF STEEL IS GREATER:

Coercive force of steel is greater because it has fat hysteresis loop.

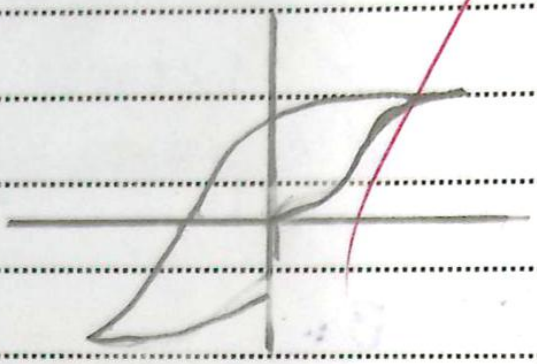
COERCIVE FORCE:

Coercive force is a force required to reduce the residual magnetic flux to zero.

Explanation:

The coercive force of steel is greater because it has larger residual magnetic flux than the copper. It's retentivity is greater than the copper. Due to which its hysteresis loop is greater means fat.

That's why the steel can be use as a permanent magnet.



Hysteresis loop of steel.

vii

ALPHA FACTOR.

Alpha factor is the ratio of collector current to the emitter current

$$\alpha = \frac{I_C}{I_E}$$

BETA FACTOR :-

Ratio of collector current to base current

$$\beta = \frac{I_C}{I_B} \quad \text{--- (1)}$$

$$I_B = I_E - I_C$$

Put I_B in (1)

$$\beta = \frac{I_C}{I_E - I_C}$$

Divide and multiply by I_E

$$\beta = \frac{I_C / I_E}{\frac{I_E - I_C}{I_E}}$$

$$\beta = \frac{\alpha}{1 - \frac{I_C}{I_E}}$$

$$\boxed{\beta = \frac{\alpha}{1 - \alpha}}$$

viii

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

Distance $(d) = 30\ cm$

$= \frac{30}{100}$

$d = 0.3\ m$

SOLUTION:

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

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

$$E = \frac{27 \times 10^3}{0.09}$$

$$E = 3 \times 10^5\ N/C$$

ix

Electron And Proton Speed:-

If Electron and proton have same de-Broglie wavelength then electron has greater speed because it is less massive than proton. Proton is 1836 times heavier than electron

Explanation:

According to de Broglie

$$\rightarrow \quad p = \frac{h}{\lambda}$$

$$\lambda = \frac{h}{p}$$

$$\lambda = \frac{h}{mv}$$

$$\lambda m = \frac{h}{v}$$

$$m \propto \frac{1}{v}$$

So we got to know that mass is inversely proportional to the velocity.

So as we know that mass is inversely proportional to velocity. so the mass of the proton is 1836 times heavier than the electron.

So electron is lighter than proton, so it will move at larger speed.

PAIR PRODUCTION:

Production of the elementary particle and its antiparticle. When the photon react with the nucleus it forms electron and positron.

Explanation:

When the photon reacts with the nucleus, it forms the positron and electron.

Law Of Conservation Of Charge:

According to law of conservation of energy, not only electron is created so to conserve charge positron is also created.

Law Of Conservation of Momentum

Photon react with the nucleus so the mast of the momentum is transfered to the nucleus to conserve momentum.

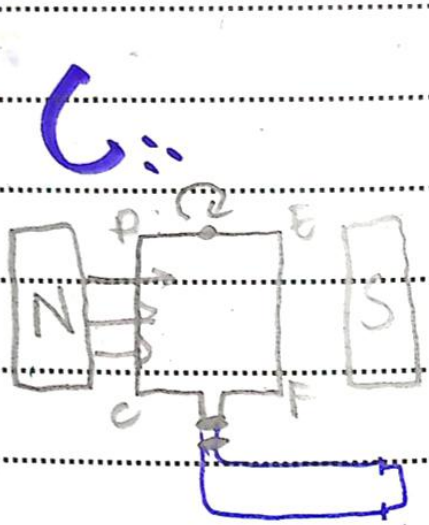
Energy of the Photon:

$$hf = 2m_0c^2 + (K.E)_+ + (K.E)_-$$

$$hf = 2m_0c^2$$

Energy of the photon is transfered to the energy of molecules formed.

SECTION C::



ANSWER 1::

AC Generator::

AC generator is a device that converts mechanical energy into the electrical energy.

CONSTRUCTION:-

It consists of

- North and south poles of magnet
- Uniform magnetic field is present.
- Armature
- Slip rings.

AC generator is made of North and South poles of magnet in which there is uniform magnetic field. Armature a rotating coil is present in the magnetic field which rotates and the emf is produced in it. It is connected to slip rings to produce the electric current.

WORKING:

During the initial position of armature, it is parallel to magnetic field so no emf is prodoced. At the half cycle when the CD moves upwards, then the current moves from C to D and then E to F. After that, it is parallel to the magnetic field so no current passes. Next half cycle EF moves upwards so current F to E and D to C so the direction of current is reversed every half cycle.

$f = \frac{1}{T}$

$\mathcal{E} = \frac{N \cdot \Delta\Phi}{\Delta t}$

$\mathcal{E} = \frac{N \cdot BA \cos\theta}{\Delta t}$

$\frac{\cos\theta}{\Delta t} = w \sin wt$

$\mathcal{E} = NBA\, w \sin wt$

$\mathcal{E}_{max} = NBA\, w$

$\mathcal{E} = \mathcal{E}_{max} \sin wt$

Part on next page

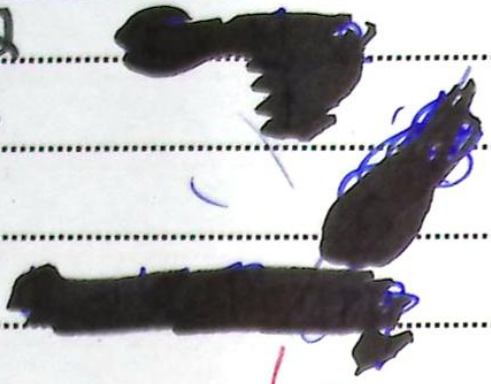
Numerical

Part *2

$\mathcal{E} = 200$

$t = 0.1$

$I = 5A$



✓ Numerical

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

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

$L = 4$ Henry

Answer *2 ::

BOHR'S POSTULATE ...

Centripetal force And fixed Orbits:

Electrons are revolving around the nucleus in fixed circular orbits called energy levels. This centripetal force is provided by the coloumb force

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

Jump to higher energy level:

When the electrons jumps from higher energy level to low energy level it releases energy.

$$E = E_n - E_p$$
$$hf = E_n - E_p$$

Angular Momentum:

Electron are revolving around orbits whose angular momentum is integral multiple of $\frac{nh}{2\pi}$

$$mvr = \frac{nh}{2\pi}$$

Radius of Electron Orbit

Bohr postulate (1)

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

$$v^2 = \frac{ke^2}{m} \quad \text{(i)}$$

We know that

According to postulate 3

$$mvr = \frac{nh}{2\pi}$$

$$v = \frac{nh}{2\pi mr}$$

Put value of v in (i)

$$\left(\frac{nh}{2\pi mr}\right)^2 = \frac{ke^2}{mr}$$

$$\frac{n^2h^2}{4\pi^2 m^2 r^2} = \frac{ke^2}{mr}$$

$$mke^2 \times 4\pi^2 = n^2h^2$$

$$r = \frac{n^2 h^2}{mke^2 4\pi^2}$$

$$\Rightarrow r = \frac{n^2 h^2}{mke^2 4\pi^2}$$

$\frac{h^2}{mke^2 4\pi^2}$ = constant

$$\frac{h^2}{mke^2 4\pi^2} = r_0$$

$$r = n^2 \times r_0$$

$r_0 = 0.53 \times 10^{-10}$

$$r = n^2 \times 0.53 \times 10^{-10}$$

Where n is the energy level, n = 1, 2, 3

Part A "Part B" "Numerical.

We know that wavelength is given

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

p = 1

n = 4

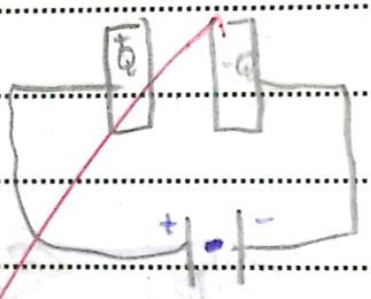
$R_H = 1.097 \times 10^7$

$\frac{1}{\lambda} = (1.097 \times 10^7)(04)\left(\frac{1}{(1)^2} - \frac{1}{(4)^2}\right)$ $\lambda = 152.8 \times 10^{-6}$ m

Answer ★ 3

Capacitance of Parallel Plate Capacitor:

capacitor



consider a capacitor is connected to the battery or the battery is connected to parallel plate capacitor. The charges are transferred on the metal plates of capacitor.

we know that electric field between metal plates that are negatively and positively charged.

$$E = \frac{\sigma}{\varepsilon_0} = \frac{Q}{A\varepsilon_0} \quad -(1)$$

We know that potential difference is developed between the plates

$$E = \frac{\Delta V}{\Delta r} = \frac{V}{d} \quad -(2)$$

comparing (1) & (2)

$$\frac{V}{d} = \frac{Q}{A\varepsilon_0}$$

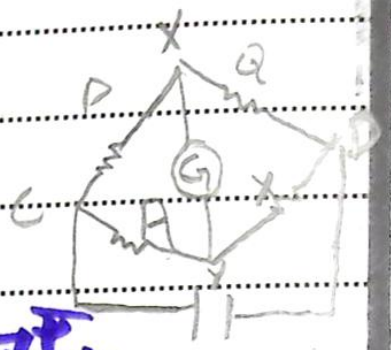
$$\frac{A\varepsilon_0}{d} = \frac{Q}{V} \qquad C = \frac{Q}{V}$$

$$\boxed{C = \frac{A\varepsilon_0}{d}}$$

For Medium

$$C = \frac{A\varepsilon}{d}$$

$$\Delta C = -\frac{A\varepsilon_r \Delta d}{d^2}$$



WHEATSTONE BRIDGE.

Wheatstone bridge is a device that is used to find the resistance of unknown resistor.

It consists of 4 resistors where 2 have fixed value, one is variable and other is unknown.

Across C and D junction battery is connected and across

X and Y Galvanometer is connected.

⟹ When the current flows, it is branched one equally across it and Galvanometer shows deflection. Variable resistor is varied until the bridge is balance and it is called Null point.

I_1 and flows across P and Q and I_2 flows across R and X. Potential is same across branches.

$$I_1 P = I_2 R$$

$$I_1 Q = I_2 X$$

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

$$XP = QR$$

$$\boxed{X = \frac{QR}{P}}$$

(Part b) Neatly solved again

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

$$\frac{1}{\lambda} = 1.09 \times 10^7 \left(\frac{1}{(1)^2} - \frac{1}{(4)^2} \right)$$

$$\lambda = 1.52 \times 10^{-6}\ m$$

By "using this" formula

$$= \frac{hc}{\lambda}$$