SECTION: B

Q:No 2

PART: (i)

Given

Distance, $r = 30\ cm$
$= 0.3\ m$

point charge, $q = 3\mu C$
$= 3\times10^{-6}\ C$

$K = 9.0\times10^{9}\ Nm^{2}C^{-2}$

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Required:

Electric field, $E = ?$

Solution:

We know that,

$$E = \frac{kq}{r^2} \rightarrow (i)$$

put values in (1)

$$E = \frac{9.0 \times 10^9 \times 3\times10^{-6}}{(0.3)^2}$$

$$E = \frac{27 \times 10^3}{(0.3)^2}$$

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

$$E = 300000$$

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

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PART: (X III)

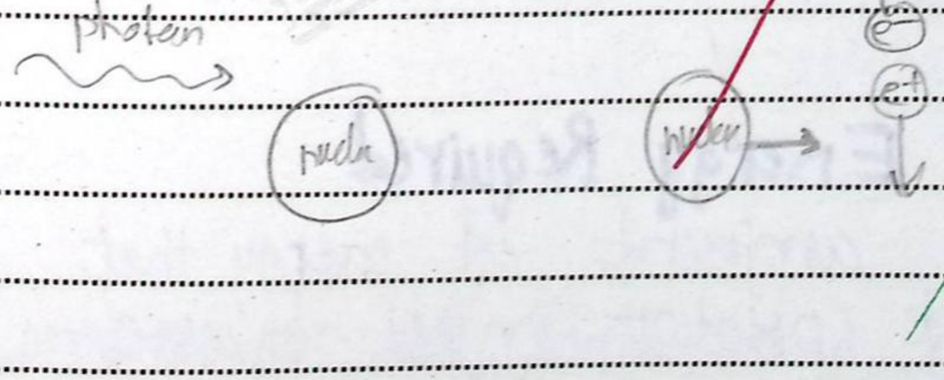
ANSWER

Pair Production:

The phenomenon in which an elementary particle and its antiparticle are created is called pair production

Usually when a photon passes near a nucleas, an elementary particle (electron) and its antiparticle (positron) are created.

$$\gamma \rightarrow e^{+} + e^{-}$$



In Accordance to $E=mc^2$

This phenomenon is in accordance with the Einstein theory that mass and energy can be inter converted.

Conservation of Charge:

The phenomenon demonstrates conservation of charge by producing electron and positron with same mass and opposite charge.

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Conservation of Momentum:

In order to conserve momentum, a heavy particle like a nucleus is needed to carry some of the momentum.

Minimum Energy Required

- Minimum amount of energy that an incident photon must have is equal to 1.02MeV

PART: (X)

ANSWER:

Coercive Force:

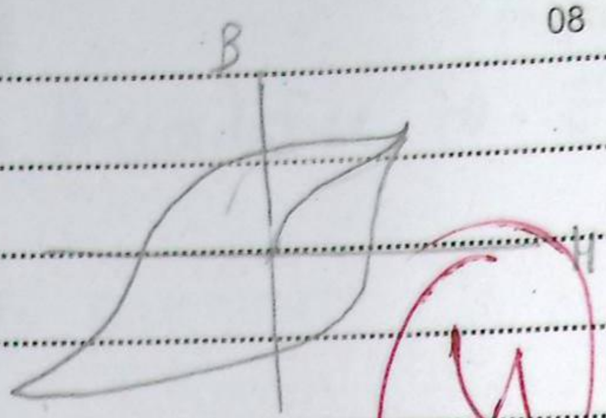
The amount of magnetizing force (H) that is required to reduce the residual magnetic flux or residual magnetism in a magnet material to zero is called Coercive force

Coercivity:

The intensity of applied magnetic field that is required to reduce residual flux in a magnetic material to zero.

Comparison of Stell and Iron:

In order to disuss the coercive force of steel and Iron we consider the hysterises loops.



For Steel

For Iron

For Steel:

From the hysteresis loop of steel we see that the area enclosed by the loop is large this means its a hard magnetic magnetic material. It is difficult to demagnetize it because large coercive force is required. Its reluctance retentivity are greater.

For Iron:

From hysteresis loop we see area enclosed by loop is small so small amount of magnetizing force is required to magnetize and demagnetize it. It's easier to reduce its residual magnetic flux to zero.

PART: (VIII)

ANSWER:

By doubling the frequency, the inductive reactance increases by a factor of 2, while capacitive reactance decreases by a factor of $\frac{1}{2}$.

Explanation:

(a) An inductor:

Inductive reactance is given by,

$$X_L = \omega L$$

$$X_L = 2\pi f L \rightarrow (1)$$

$$X_L' = 2\pi f' L \qquad f' = 2f$$

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

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

$$X_L' = 2(X_L)$$

So inductive reactance increases by a factor of 2.

(b) A Capacitance:

The capacitance reactance is given by

$$X_c = \frac{1}{\omega C} \rightarrow (2)$$

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

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

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

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

$$X_c' = \frac{1}{2(X_c)} \times$$

So capacitance decreases by a factor of

1/2

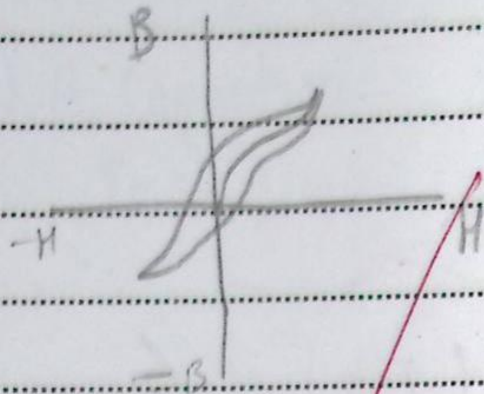
PART: (ix)

ANSWER

(4)

Soft Magnetic Materials	Hard Magnetic Materials
The magnetic materials with narrow hysteresis loop are called soft magnetic materials	The magnetic materials with fat hysteresis loop are called hard magnetic materials
They are easy to magnetize and demagnetize	They are hard to demagnetize.
They require less coercive force	They require more coercive force.

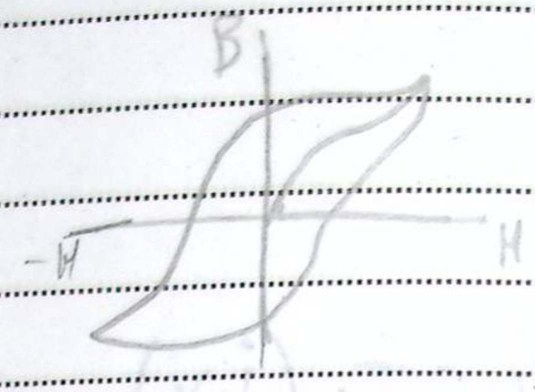
Hysteresis loops are as follows



Examples:

Soft iron

They are used in transfer cores.



Example

Steel.

They are used to make permanent magnets.

PART: (II)

ANSWER:

Potential Gradient:

Rate of change of potential difference with respect to displacement is called potential gradient.

$$E = -\frac{\Delta V}{\Delta r} \rightarrow (1)$$

Derivation:

Consider two plates A and B which are oppositely charged as shown. A is at higher potential and B is at lower potential. Consider a point charge q_o placed in between plates. We move it from B to A against direction of field, so we do work on it. This work is stored as potential energy in the point charge. Point charge moves distance Δr

$$\Delta W_{B\to A} = F.\Delta d$$

$$\Delta W_{B-A} = F.\Delta r$$

$$\Delta W_{B-A} = + (q_o E)\Delta r \cos 180^\circ$$

$\Delta W_{B\to A} = -q_0 E \Delta r$

$\frac{\Delta W_{B-A}}{q_0} = -E\Delta r$ as $\frac{\Delta W}{q_0} = V$

$\Delta V = -E\Delta r$

$-E\Delta r = \Delta V$

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

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

4

Conclusion:

Hence by above discussion we have proved that;

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

PART: (XII)

ANSWER:

The electron, which has lesser mass than proton will have greater velocity.

Exploration:

According to De-Broglies hypothesis,

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

$$\lambda = \frac{h}{mv} \rightarrow (1)$$

(4)

We have been given condition that both electron and proton have same debroglie wavelengths so (1) can be rearranged as

$$V = \frac{h}{\lambda m}$$ Here $\frac{\lambda}{m}$ = constant

$$V \propto \frac{1}{m} \rightarrow (2)$$

So by ② we conclude that velocity of particle varies inversely with mass. For same debroglie wavelength, electron will have greater speed.

PART: (Xi)

ANSWER:

For transistor, $\alpha = \frac{I_C}{I_E} \rightarrow ①$

$$\beta = \frac{I_C}{I_B} \rightarrow ②$$

Now $I_B = I_E - I_C$ put in ②

$$\beta = \frac{I_C}{I_E - I_C} \rightarrow ③$$

Now dividing both numerator and denomenator in (3) by I_E

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

Since $I_C/I_E = \alpha$ so we put it in above equation,

$$\boxed{\beta = \frac{\alpha}{1-\alpha}} \rightarrow (4)$$

(4)

Hence proved,

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

PART: (V)

ANSWER:

Ohm's Law:

Presented By
George Simon Ohm

Statement:

"Current (I) flowing in a conductor is directly proportional to the applied voltage (V) provided that the temperature (T) of the conductor remains constant.

Mathematical Form

$$I \propto V \rightarrow (1)$$

$$I = \frac{V}{R} \rightarrow (2)$$

R = constant called resistance of conductor.

By (2)

$$V = IR \rightarrow (3)$$

$$R = \frac{V}{I} \rightarrow (4)$$

Ohmic Substances	Non-Ohmic Substances
Substances that obey ohms law are called Ohmic substances.	Substances that donot obey ohms law are called non-ohmic substances.
Example: Metals	Examples: Thermistor
I/V Graph is a straight line	I/V graph is a curved line.

PART: (iv)

ANSWER:

Volt:

Volt is the unit of potential difference

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

$$V = \frac{J}{C}$$

Electron Volt:

Electron volt is the amount of energy acquired by or dissipated by an electron as it is moves across two points between which the potential difference is 1 V.

Relation:

$(eV) = V \times q_{(elementary\ charge)}\ e^-$

$eV = (1) \times 1.6022 \times 10^{-19}$

~~Relation~~: $eV = 1.6022 \times 10^{-19} J$

Difference:

Volt is the unit of potential difference where as electron volt is the amount of energy.

So Volt and electron volt are different physical quantities.

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Potential difference is the property of electric field where as eV is the property of charge placed in that field.

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SECTION : C

Q:No 6

PART : (C)

ANSWER:

Nuclear Fission:

The reaction in which a larger nuclei breaks apart into intermediate size nuclei is called Nuclear Fission

Parent Nucleus:

The nucleus that breaks into intermediate size nuclei is called Parent Nucleus

Daughter Nucleus:

The intermediate size nuclei produced are called daughter nucleus.

Energy Released:

The total energy released is

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CONTINUATION SHEET

Fic. No. Va3

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about 200 MeV.

Fission Fragments:
The larger nucleus breaks into smaller nuclei called fission fragments.

General Reaction:

$_0^1n \; X \rightarrow X^* \rightarrow A + Y + {}_0^3n + \gamma$

Example:

$^{235}_{92}U + {}^1n \rightarrow {}^{236}_{92}U^* \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + {}^3_0n + \gamma$

$^{236}_{92}U^*$: It is called intermediate excited state. It's short lived about 10^{-8} s.

Discovered By:

It was discoved by Otto Hah and Strassmann In 1938.

PART: (b)

ANSWER

Wheatstone Bridge:

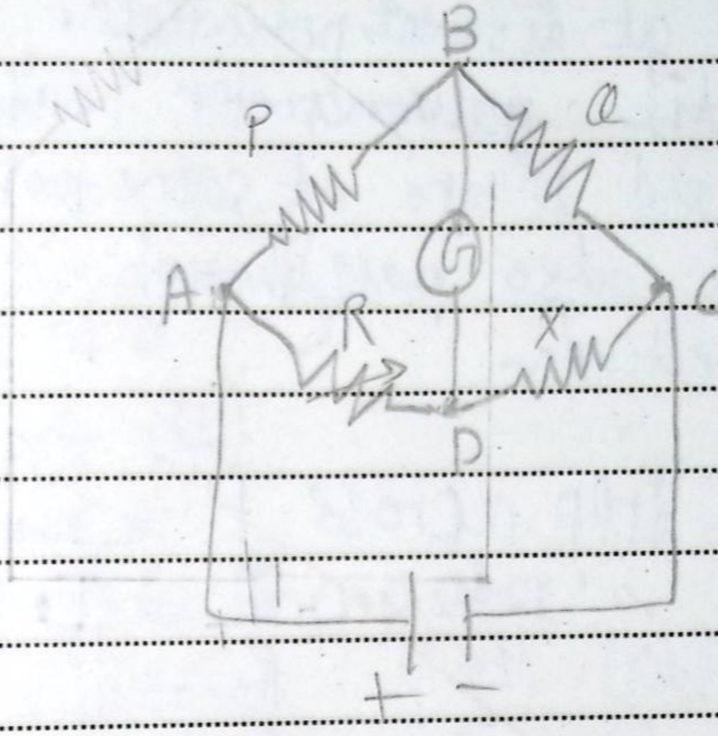
Proposed By:

It was proposed by British telegraph engineer Wheatstone.

Proposed For:

It was proposed to determine value of unknown Resistance X.

Construction and Working:



~~Also~~ It consists of four resistances, P, Q which are fixed resistances, R which is a variable resistance and X is a unknown resistance whose value is to be determined.

Across Junction A and C a battery is connected. Across Junction B and D a galvanometer is ~~take~~ attached.

Current at A divides into I_1 and I_2. I_1 goes through P while I_2 goes through R initially it shows deflection which shows B and D are at different potentials. R is varied until galvanometer reads zero. Now B and D are at same potential. I_2 and I_1 also pass through X and Q respectively.

Now

Potential drop across $P = I_1 P$

" " " $Q = I_1 Q$

" " " $R = I_2 R$

" " " $X = I_2 X$

Now,

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

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

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

4

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Q:No. 3

Part (a)

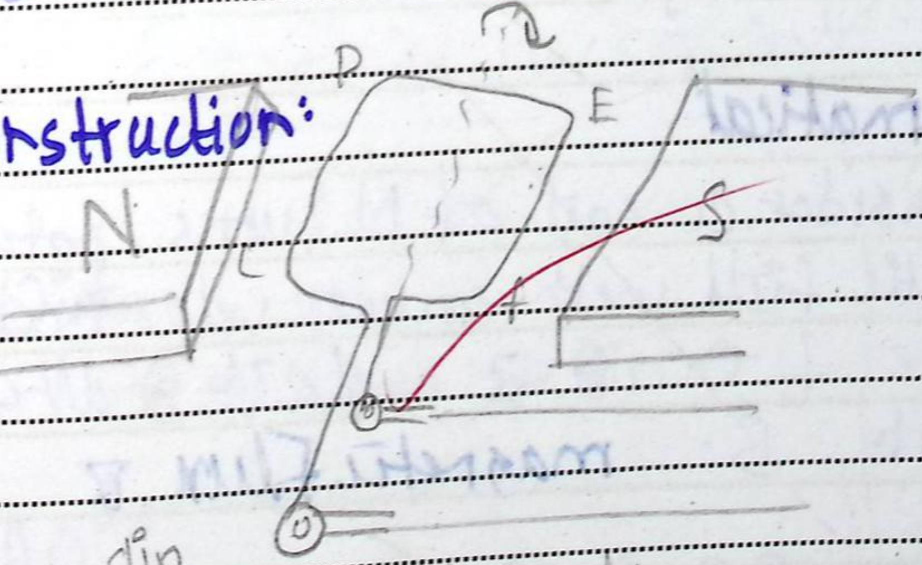
Answer:

AC Generator:

A device that converts mechanical energy into electrical energy is called a generator.

A generator that produce alternating current is called AC Generator

Construction:



It consists of a coil CDEF which is rotated between the two poles of magnet. Slip rings are used which help to produce ~~AC~~ alternating current.

?

Working:

The Coil CDEF rotates. initially direction of current is from C to D and E to F. After half cycle CD is in place of FE and FE is in place of CD. Now direction of current is reversed and is from F to E and D to C. This keeps on happening every half cycle.

Mathematical

Consider a coil of N turns rotates in magnetic field with angular velocity w in time t. θ is angle it makes with B. magnetic flux is

$\Phi = BA \cos\theta$

$\Phi = BA \cos \omega t \quad \theta = \omega t$

By Faraday's law

$$|\mathcal{E}| = \frac{N\Delta\phi}{\Delta t}$$

$$\mathcal{E} = \frac{NBA\cos\omega t}{\Delta t}$$

$$\mathcal{E} = NBA\frac{\Delta\cos\omega t}{\Delta t}$$

$$\mathcal{E} = NBA\,\omega\sin\omega t$$

$$\mathcal{E} = NBA\ (1)$$ In maximum condition

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

$$\mathcal{E} = \mathcal{E}_{max}\,\omega\sin\omega t$$

4

Graph

At 0°:

$$\mathcal{E} = \mathcal{E}_{max}\,\omega\sin\theta$$

$$\mathcal{E} = 0$$

$\sin 0° = 0$

At 90°:

$$\mathcal{E} = \mathcal{E}_{max}\,\omega\sin 90°$$

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

?

At 180°C:

$\mathcal{E} = \mathcal{E}_{max}\ w\sin 180°$

$\mathcal{E} = \mathcal{E}_{max}\ 0$

At 270°:

$\mathcal{E} = \mathcal{E}_{max}\ w\sin 270°$

$\mathcal{E} = -\mathcal{E}_{max}$

At 360°C:

$\mathcal{E} = \mathcal{E}_{max}\ w\sin 360°$

$\mathcal{E} = 0$

?

Part:(b)

Given:

$I_i = 5.0A$

$I_f = 0A$

$\Delta t = 0.1s$

$\mathcal{E} = 200V$

Required:

Self inductance = ?

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Solution:

We know,

$$\varepsilon = \frac{L \Delta I}{\Delta t} \quad \text{rearranging,}$$

$$L = \frac{\varepsilon \Delta t}{\Delta I}$$

$$L = \frac{(200)(0.1)}{(5.0-0)}$$

$$\boxed{L = 4H}$$

4

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Q: No. 4

Part: (a)

ANSWER:

Bohr's Model of Hydrogen Atom:

After Rutherford's proposal that mass and positive charge are present at centre in a very small region of atom called nucleus.

After that Bohr presented his model of Hydrogen atom.

He proposed that electrons resembled planetary system, that electrons are revolving around nucleus like planets. Classical physics required they must emit EM radiation but to overcome this Bohr said there are special states called stationary states where electron donot radiate energy.

He also supported by saying the angular momentum in these states is quantized, $mvr = \frac{nh}{2\pi}$

1st Postulate:

There is Coulombic force of attraction between electron and nucleus due to opposite charges. This provides centripetal force to electron to revolve around nucleus

$$F_c = F_{coulomb}$$

$$\frac{mv^2}{r} = \frac{Ke^2}{r^2} \rightarrow (1)$$

2nd Postulate:

2nd postulate stated that the angular momentum of electrons in the quantized stationary orbits is quantized. Its integral multiple of $\frac{h}{2\pi}$

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

$$mvr = \frac{nh}{2\pi} \rightarrow (2)$$

3rd Postulate:

When electron goes from higher energy level to lower energy level it radiates energy which is given by,

$$E = E_n - E_o$$

$$hf = E_n - E_o$$

higher lower.

Radii of Quantized orbits:

There are special orbits. They are quantized orbits. They are found as,

By first postulate $\frac{m_e v^2}{r_n} = \frac{ke^2}{r_n^2}$

$$m_e v^2 = \frac{ke^2}{r_n} \rightarrow (1)$$

By 2nd Postulate $m_e v r_n = \frac{nh}{2\pi}$

$$v = \frac{nh}{2\pi m_e r_n}$$ put in (1)

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$$m\left(\frac{nh}{2\pi m_e r_n}\right)^2 = \frac{ke^2}{r_n}$$

$$m_e \frac{n^2h^2}{4\pi^2 m_e^2 r_n^2} = \frac{ke^2}{r_n}$$

$$\frac{n^2h^2}{4\pi^2 m_e r_n} = ke^2$$

$$r_n = \frac{n^2h^2}{4\pi^2 m_e ke^2}$$

$$r_n = n^2 \times \frac{h^2}{4\pi^2 m_e ke^2}$$

n^2 = variable

$\frac{h^2}{4\pi^2 m_e ke^2}$ = constt

$$r_n = n^2 \times 0.53 \times 10^{-10}\,m$$

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Part: (b)

Given:

$n = 4$

$q_e = 1.6022 \times 10^{-19}\ C$

$m_e = 9.11 \times 10^{-31}\ kg$

Required:

$\lambda = ?$

Sol:

$$V = \frac{2.16 \times 10^6}{n}$$

$$V = \frac{2.16 \times 10^6}{4}$$

$V = 546694.064\ m/s$

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

$$\lambda = \frac{6.6262 \times 10^{-34}}{9.11 \times 10^{-31} \times 546644.064}$$

$\lambda = 1.33$ nm

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