SECTION : B

SHORT ANSWERS

Answer : 01

Given Data:

Point charge = q = $3 \mu C = 3 \times 10^{-6} C$
Distance = r = $30 cm$ = $0.3 m$

To find:

$E = ?$

Solution:

As we know that

$$E = \frac{F}{q} = K\frac{q}{r^2}$$

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

$$= \frac{2.7 \times 10^4}{0.09}$$

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

Answer : 02

To Prove : $E = -\frac{\Delta V}{\Delta r}$

Definition:

The change in potential difference with change in distance is called Potential gradient.

Proof:

As we know $\Delta V = \frac{W}{q}$

Now, $\Delta V = \frac{F \cdot d \cos\theta}{q}$ $(W = Fd\cos\theta)$

$\Delta V = \frac{Fd\cos 0^\circ}{q}$ (As test charge direction)

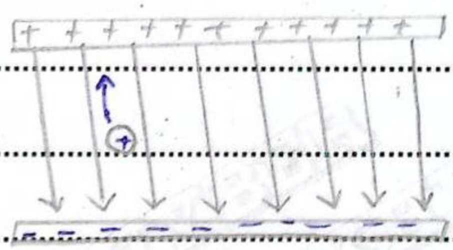
$\Delta V = \frac{\cancel{q} E \Delta r (1)}{\cancel{q}}$ $(F = qE)$ (d considered as Δr)

$$\Delta V = E \cdot \Delta r$$

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

The negative sign shows that the direction of test charge is opposite to that of Electric field.

Diagram:



Answer : 08

The double of frequency affect the reactance in the following way:

(a) For Inductor :

As we know that

$$X_L = \omega L$$

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

$X_L \propto f$

Doubling frequency:

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

$X_L = 2 \, 2\pi f L$

$\boxed{X_L = 2X_L'}$

For Capacitor:

As we know that

$X_C = \dfrac{1}{\omega C}$

$X_C = \dfrac{1}{2\pi f C}$ $\quad \because \omega = 2\pi f$

$X_C \propto \dfrac{1}{f}$

Doubling frequency:

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

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

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

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

4

Result:

- Inductive Reactance doubles
- Capacitive Reactance halves.

Answer: 11

To prove: $B = \frac{\alpha}{1-\alpha}$

Relation:

Basically, the upper equation

Shows relationship between alpha and beta factor.

Alpha factor:

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

Def:
The ratio of collector current to that of emitter current is called Alpha factor.

Beta factor:

Def:
The ratio of collector current to that of base current is called Beta factor.

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

Proof:

As beta factor = $\beta = \frac{I_C}{I_B}$

$$\beta = \frac{I_C}{I_E - I_C} \qquad (\text{As } I_E = I_C + I_B)$$

Dividing I_E on Right hand side.

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

$$\beta = \frac{\alpha}{1-\alpha} \rightarrow (i) \qquad \left(\alpha = \frac{I_C}{I_E}\right)$$

Hence proved ⇒ equation (i)

Answer : 12

Electron will have greater speed

Explanation:

As we know that

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

$$\lambda = \frac{h}{mv} \quad (p = mv)$$

4

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

As wavelength λ = same and h = constant :

So : $v = \text{constant} \frac{1}{m}$

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

Now mass of proton > mass of electron

$m_p > m_e$

$\boxed{V_E > V_P}$

Answer : 09

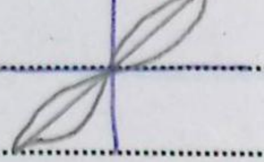
Soft Magnetic Materials :

Those materials which easily lose and gain their magnetic properties are called Soft Magnetic Materials.

Hard Magnetic Materials:

Definition:

Those material which donot lose their magnetic properties easily and retain their magnetization are called **Hard Magnetic Materials**.

Soft Magnetic Materials	Hard Magnetic Materials
(i) They have low coercivity	They have high coercivity.
(ii) They have low retentivity	The have high retentivity
(iii) They have small hysterisis loop	They have large hysterisis loop
(iv) 	
(v) Easy Magnetization	Difficult Magnetization

Answer : 10

Statement:

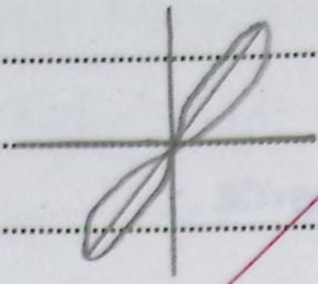
Coercive force of steel is greater than iron

* **Coercive force:**
Reverse external Magnetization is called **Coercive force**.

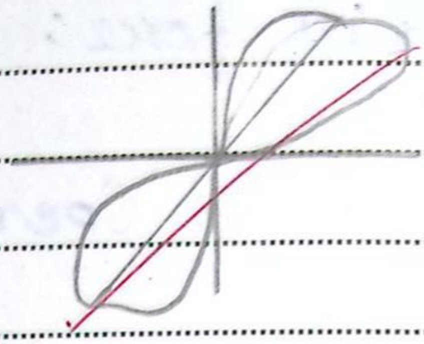
* **Retentivity:**
The ability to retain magnetization is called **Retentivity**.

Now:
Coercive force of steel is greater than iron because steel has greater retenetivity. It means that the domain of steel has greater retentivity and the magnetization is retained by steel even the magnetization is reduced to zero. So the coercive force of steel will also be greater because coercivity is opposite of retentivity.

Hence due to high retentivity steel has higher coercive force than iron.



hysterisis loop for iron



hysterisis loop for steel

Answer : 13

Pair Production:

Definition:

The phenomenon of formation of positron and electron from a Gamma Photon is called **Pair Production.**

$$\gamma \longrightarrow e + p + \text{energy}$$

Explanation:

In Pair Production charge, momentum and Energy are conserved.

Energy Conservation:

As Gamma ray Photon is converted into electron and positron, energy is also released.

$$K.E = 2hf + m_oc^2 + m_oc^2$$

$$K.E = 1.02 \text{ MeV}$$

4

Momentum Conservation:

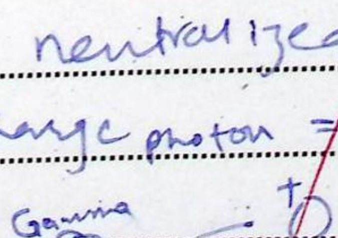
For momentum conservation, the heavy nucleus is taken which equals momentum with electron, positron

$$P_{nucleus} = P_{electron} + P_{positron}$$

Charge Conservation:

Charge is also conserved. As Gamma Photon is neutral, so the two charges electron and positron produced are neutralized.

$$\text{Charge}_{photon} = \text{Charge}_{electron} + \text{Charge}_{positron}$$



Answer : 05

Ohm's law:

for Metals current is directly proportional to the Voltage as long as Physical properties remain constant

$I \propto V$

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

$V = IR$

Limitation:

* It is only used for metals.
* It cant be used for unilateral electrical components
* It cant be applied for varying Temperature.

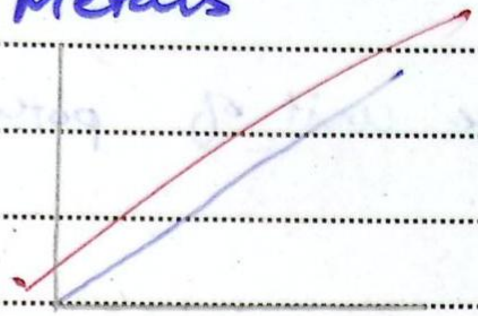
Ohmic Devices:

Those devices which obey

Ohm's law are called Ohmic devices.

Example: Metals

I



V

$\frac{1}{R}$ = Constant.

Non Ohmic Devices:

Those Devices which donot obey Ohmic law.

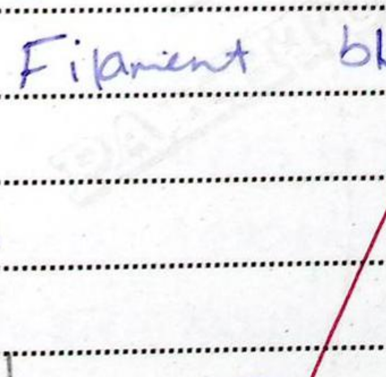
4

Example:

Filament bulb, Therimistor.

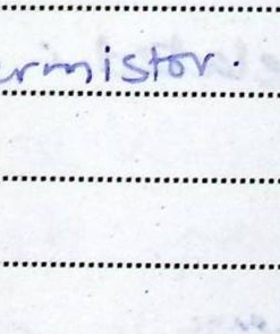
Graph:

I



V

for filament bulb



Thermistor

Answer : 04

Volt :

It is the unit of potential difference.

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

eV :

It is the energy lost or gained when charge is moved in the plates having 1 potential difference.

$1eV = 1.6 \times 10^{-19} C$

3

Related :

eV is relation to Volt in such way that eV is produced when charge is moved in plates having 1 potential difference.

SECTION : C

QUESTION : 03

Part (a)

8+1

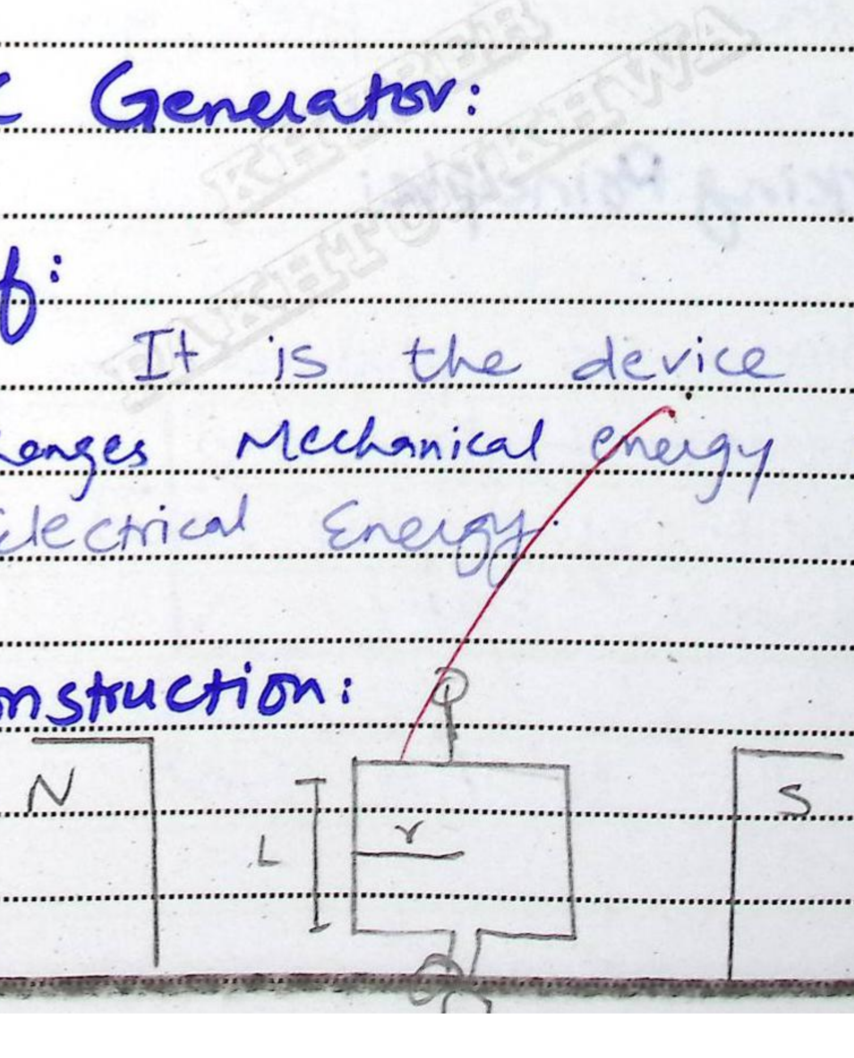
Answer:

A.C Generator:

Def:

It is the device which changes Mechanical energy into electrical Energy.

Construction:



(i) It consists of Strong Magnetic Field.

(ii) In strong Magnetic field, the coil having N turn is present.

(iii) Coil is connected with slip rings. and Carbon Brushes.

(iv) Carbon Brushes act as terminals to draw current from generation

Working Principle:

Torque is produced in Magnetic field which magnetic flux and that induces Motional EMF.

$$T = NWAB \sin\theta$$

Derivation:

As we know that Motional EMF is produced.

?

$E = VLB \sin\theta$

$E = 2r\omega LB \sin\theta$ $(V = r\omega)$

$E = A\omega B \sin\theta$ $2rL = A$

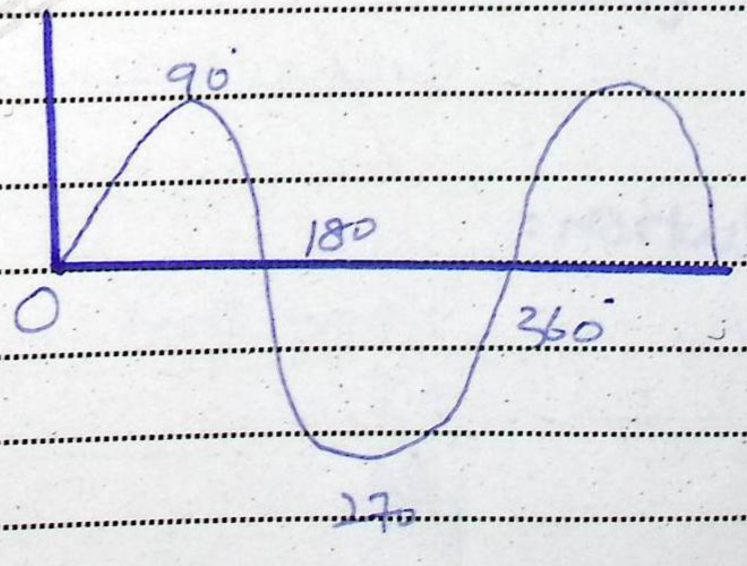
For N turns:

+1

$E = N\omega AB \sin\theta.$

Current produced = $I = I_m \sin \omega t$.

Graph:



Current at 0° = $I = I_m \sin 0^\circ = 0$
Current at 90° = $I = I_m \sin 90^\circ = I_m$
" " 180° = $I = I_m \sin 180^\circ = 0$
" " 270° = $I = I_m \sin 270^\circ = -I_m$
" " 360° = $I = I_m \sin 360^\circ = 0$

Part (b)

Given Data:

Current = I_f = 0 A
" = I_i = 5A
Time = t = 0.1s
EMF = ε = 200V

To find:

Self Inductance = ?

Solution:

As we know that

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

$$L = -\frac{\mathcal{E}}{\frac{\Delta I}{\Delta t}} = -\left(\frac{200}{\frac{0-5}{0.1}}\right)$$

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

$$= -\left(\frac{20}{-5}\right)$$

$$= -(-4)$$

$$\boxed{L = 4 \ VsA^{-1}}$$

4

QUESTION: 04

Part (a): 5+1

Neil Bohr:

Neil Bohr present his postulates about Hydrogen atom in 1913.

Postulates:

His postulates are following:

(i) Electrons are revolving arround nucleas in fixed circular path called Orbitats. This centripetal force is provided to electron by Columb force.

$$\frac{mv^2}{r} = k\frac{q_1 q_2}{r^2}$$

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CONTINUATION SHEET

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(ii) Electrons gains or losses energy when they jump from lower to higher energy level or comeback to lower energy level

$$\Delta E = hf$$

$$E_2 - E_1 = hf$$

(iii) Electrons revolve around nucleas only when they have angular momentum or integral multiple of it.

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

where $n = 1, 2, 3 \ldots -$.

Radius for Hydrogen:

Consider an electron that revolves around nucleas. Columb force is present in between electron and nucleus

$$F_c = \frac{Ke^2}{r^2}$$

Electron undergoes centripetal forces due to which it revolves

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

Columb force = Centripetal force

$$\frac{Ke^2}{r^{\cancel{2}}} = \frac{mv^2}{\cancel{r}}$$

$$mv^2 = \frac{Ke^2}{r} = v^2 = \frac{Ke^2}{r m} \rightarrow$$

As Angular momentum is given by

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

Squaring eq② on both sides

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

$$r^2 = \frac{n^2h^2}{4\pi^2 m^2 v^2} \rightarrow ③$$

Put value of $v^2 = \frac{Ke^2}{rm}$ in ③

$$r^{\cancel{2}} = \frac{n^2h^2}{4\pi^2 m^{\cancel{2}} \left(\frac{Ke^2}{\cancel{r}\,\cancel{m}}\right)}$$

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

$$\boxed{r = n^2\left(\frac{h^2}{4\pi^2 Ke^2 m}\right)}$$

$$\boxed{r = n^2 \times 0.529\ \text{Å}}$$

Part (b):

Given: 6

state = n = 4

TO find:

λ = wavelength = ?

Solution:

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

As (n = p+1)
p = n−1

$$= 1.09678 \times 10^7 \left(\frac{1}{3^2} - \frac{1}{4^2} \right)$$

$$\frac{1}{\lambda} = 1.09678 \times 10^7 \left(\frac{1}{9} - \frac{1}{16} \right)$$

$$\frac{1}{\lambda} = 1.09678 \times 10^7 \left(\frac{16-9}{144} \right)$$

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$$\frac{1}{\lambda} = 1.09678 \times 10^{7} \left(\frac{7}{144}\right)$$

$$\frac{1}{\lambda} = 533156.9444 \text{ m}$$

$$\lambda = \frac{1}{533156.9444} \text{ m}$$

$$\lambda = 1.8756 \times 10^{-6} \text{ m}$$

QUESTION: 06

8 +1

Part (a):

Parallel Plate Capacitor:

The capacitor in which plates are present parallel to each other.

Consider that charge starts storing. It is stored and charge is build up until potential V. let $+q$, $-q$ be the charges at potential V.

$$\Delta V = \frac{\varepsilon}{\Delta d} \rightarrow \Delta V = \varepsilon \cdot \Delta r \rightarrow (2)$$

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

Equation (1) shows that the potential is maintained in the plates having distance r.

$$\varepsilon = \frac{V_2 - V_1}{\Delta r} \text{ or } \frac{V_2 - V_1}{\Delta d}.$$

8

Then is charge on plates as well

$$\sigma = \frac{Q}{A} \qquad \frac{Q}{V} = C \qquad = V = \frac{Q}{C}$$

$$\sigma A = Q \qquad V = \frac{\sigma A}{C} \rightarrow (1)$$

comparing ①, ②

$$\varepsilon \Delta l = \frac{\sigma A}{C}$$

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

$\Delta l = d$

$$C_o = \frac{A\varepsilon_o}{d} \rightarrow \text{for permitivity of free space}$$

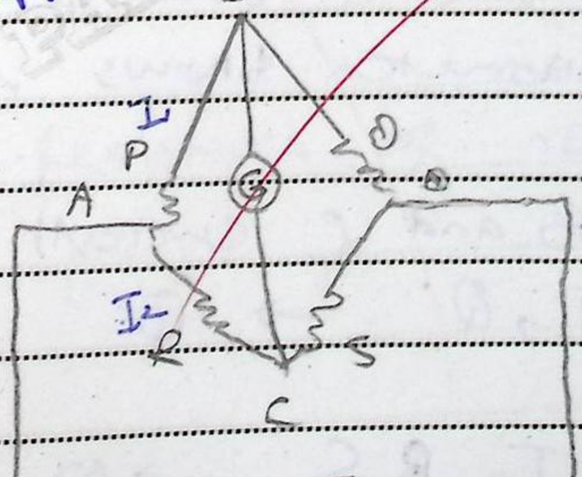
Answer : (b) $C_m = \frac{A\varepsilon_m}{d} \rightarrow$ for material medium

Wheatstone Bridge:

Def:

It is the set of resistors used to find out an unknown resistor

Diagram:



Construction:

* Consider a structure in which two known fixed resistors are present: ie P, Q
* One known variable is present ie R
* While one unknown resistor is present ie S

Working:

The current flows through bridge until resistors are fixed as such that the Galvanometer deflection becomes zero.

5

Null condition:

The condition in which potential drop at B and C becomes equal and Galvanometer shows no deflection

Current:

At Point B and C current is same.

$I_1 P = I_2 Q \rightarrow (1)$

and $I_1 R = I_2 S \rightarrow (2)$

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Divide 1 by 2

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

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

$PS = RQ$

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

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

Hence resistance of resistor S can be found