Section: B

Question: 02

(Part: i)

Answer:

Given Data:

Charge = $Q = 3\,\mu C$

Distance = $r = 30cm = 0.3m$

constant = $K = 9 \times 10^9\ Nm^2C^{-2}$

Required:

Electric Field = $E = ?$

Solution:

As we know that;

$$E = K\frac{Q}{r^2}$$

putting values;

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

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

(Part: iv)

Answer:

Units of volt and electron volt are related and they are also different from eachother.

Reason and Explanation:

Volt:

Volt can be defined as 1 joule of workdone to move a point charge from infinity to a point in an electric field.

* Volt is the unit of Potential difference V
* Volt can be denoted as V.

Electron volt: (ev)

Electron volt is the amount of energy required to move a charge in an electric field when the potential difference is one volt.

Relation between V and eV:

Volt and electron volt are related in such a way that;

$$1eV = Q \times V \quad - (1)$$

when $V = 1$ and charge on electron is $1.6 \times 10^{-19} C$ So putting values in eq. (1) we get;

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

$$[1eV = 1.6 \times 10^{-19} J]$$

So, we have from the equation that $1eV = 1.6 \times 10^{-19} V$.

Difference:

There is a huge difference volt and electron volt which is as follows;

* They both are different physical quantities.
* Volt is the unit of potential difference while eV is the unit of energy.

(Part: V)

Answer:

Ohm's Law:

Ohm's Law shows the relationship between Voltage V. Current I and resistance R at constant temperature.

Statement:

Ohm's Law states that:

"The current in a conductor is directly proportional to the applied voltage and long is the temperature in a conductor is kept constant."

Mathematically:

As from the statement of Ohm's Law:

$$V \propto I$$

So changing proportionality into equality we add a constant;

$V = RI$

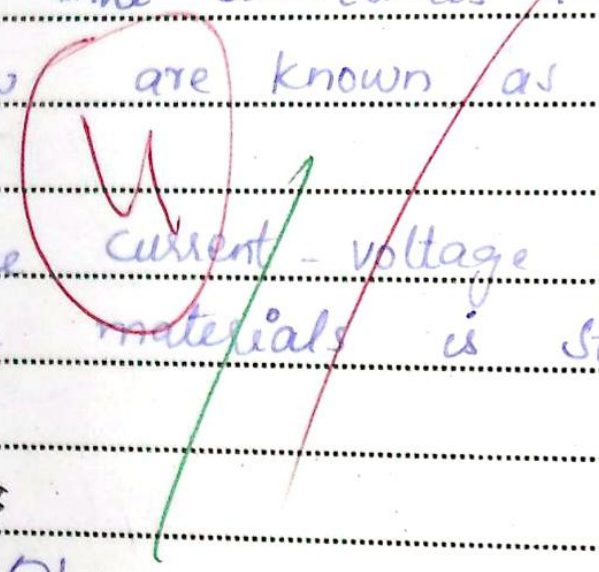
or $V = IR$

where R is the proportionality constant which is known as resistance and $R = \frac{V}{I}$ at constant temperature

Ohmic Substances:

*. The substances that follows ohms Law are known as ohmic substances.

*. The current - voltage graph for ohmic materials is straight line.



Examples:

Ohmic substance is Energy Saver.

Non-Ohmic Substances:

* Those substances that donot follow Ohm's Law are known as Non-Ohmic substances.

*. For Non-Ohmic substances the IV graph is curved and not straight.

Examples:

Examples of Non-Ohmic substances are : i) Tungsten wire.
ii) Bulb etc.

(Part: vii)

Answer:

Current carrying coil behaves like a bar magnet because of its construction and having North and South poles.

Explanation:

- As Bar magnet is a magnet in rod shape having north and South poles.
- Current carrying coil is made of armature rounded with a copper wire tightly.

Coil as a bar magnet:

- When current is passed through a coil having number

of turns so emf is induced in the coil so, it started acts like a bar magnet and North and South poles are generated and started to created magnet field around itself.

Conclusion:

So, in this way the current carrying coil acts as a bar magnet and produces N-S poles.

Part: viii

Answer:

By doubling the frequency the reactance of inductor will be doubled and the reactance of a capacitor will be reduced to half.

Explanation:

Formula of inductive reactance X_L is: $X_L = 2\pi fL$

Formula for capacitative reactance X_C is; $X_C = \frac{1}{2\pi fC}$

Doubling frequency of an inductor:

As we know that; $X_L = 2\pi fL$

When $f = 2f$ so,

$X_L' = 2\pi(2f)L$ (4)

$X_L' = 2(2\pi fL)$ $\therefore 2\pi fL = X_L$

So,

$$\boxed{X_L' = 2X_L}$$

So, by doubling frequency inductive reactance X_L doubles.

Doubling frequency of Capacitor:

As we know that;

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

By doubling frequency

$$X_C' = \frac{1}{2\pi(2f)C} \quad \therefore \frac{1}{2\pi fC} = X_C$$

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

So,

$$X_C' = \frac{1}{2}(X_C)$$

So, by doubling frequency X_C is reduced to half.

Part: ix

Answer:

Soft Magnetic	Hard Magnetic
1- Soft Magnetic materials are those materials that can easily be magnetized and demagnetized.	2- Hard magnetic materials are those materials that cannot be easily magnetized and demagnetized.
2- Soft magnetic materials has thin hysteresis loop.	2- Hard magnetic material has fat hysteresis loop.
3- They cannot be used as permanant magnets.	3- They are used to make permanant magnets.
4. Examples: • iron	4. Examples: • steel

(Part: x)

Answer:

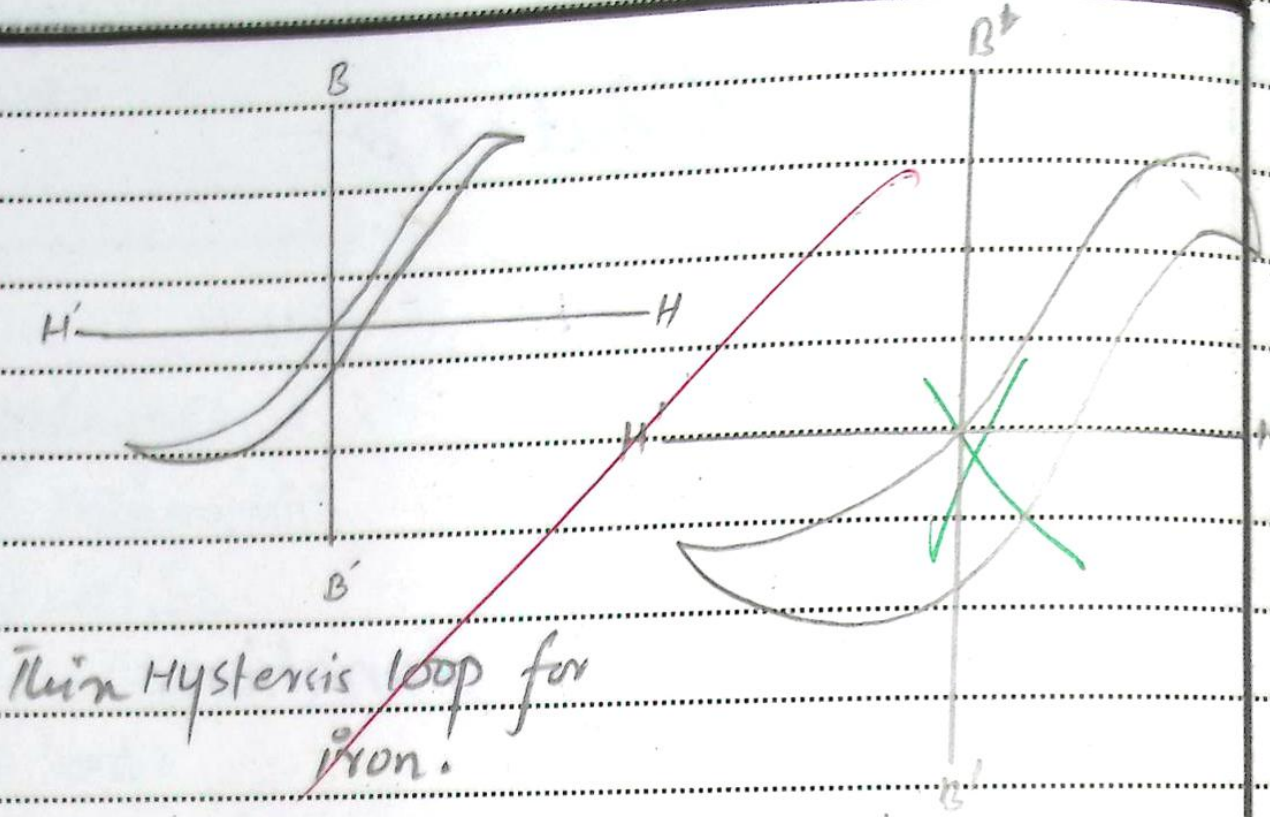
Corecive force of steel is greater than iron because retentivity of steel is greater than iron.

Reason and Explanation:

Retentivity: Corecive force of steel is greater than iron because of the value of retentivity of steel which is greater than iron.

Hysteresis loop: The hystersis loop for iron is thin because it cannot retain its magnetization and de magnetized easily.

The hysteresis loop for steel is fat because it has more retentivity to maintain its magnetization and cannot de magnetized easily.



Thin Hysteresis loop for iron.

Fat hysteresis loop for steel

(Part: xi)

Answer:

For transistor $\beta = \frac{\alpha}{1-\alpha}$

Proof:

As we know that;

$\beta = \frac{I_C}{I_B}$ $\quad \therefore I_B = I_E - I_C$

$\beta = \frac{I_C}{I_E - I_C}$ $\quad \therefore$ dividing by I_E

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

As $\alpha = I_c / I_E$

so, putting values we get.

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

Hence proved.

P.T.O

(Part: vi)

Answer:

Following are the factors that affect the inductance;

1. Length
2. Area
3. Permibility
4. Number of turns.

Length:

By increasing the length of inductor the induction decreases

Area:

Area is also directly proportional to inductances. By increasing the Area induction increases.

Permibility:

Permibility is also directly proportional to inductance.

Number of turns N:

By increasing the number of turns in inductor So, its inductance increases and more are current flow through it.

(Part: xii)

Answer:

If an electron an proton has the same de-Broglie wavelength Electron will have the greater speed.

Reason and Explanation:

As we know that

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

re-arranging:

$$v = \frac{h}{m\lambda} \quad \text{①}$$

As h is the plank's constant and λ is the de-Broglie wavelength which is same for both electron and proton So,

$V \propto \frac{1}{m}$ keeping the h and λ constant:

So, As from $V \propto \frac{1}{m}$ the speed is Inversly proportional to the mass of substances.

The substance having less mass will be having greater speed.

As the mass of electron is 1846 times smaller " in proton so electron will be having greater velocity.

Section: C

Question: 03

(a)

AC Generator:

AC generator is a device which converts mechanical energy into electrical Energy.

- It works on the principle of electromagnetic induction.

Construction:

AC generator consists of a magnet having north and south poles.

In between the poles of magnet there is a coil which is rectangular in shape at the end of the coil

there are rings known as slip rings which provide alternating current voltage to the generator. It certain brushes which connect slip rings to the outer potential difference.

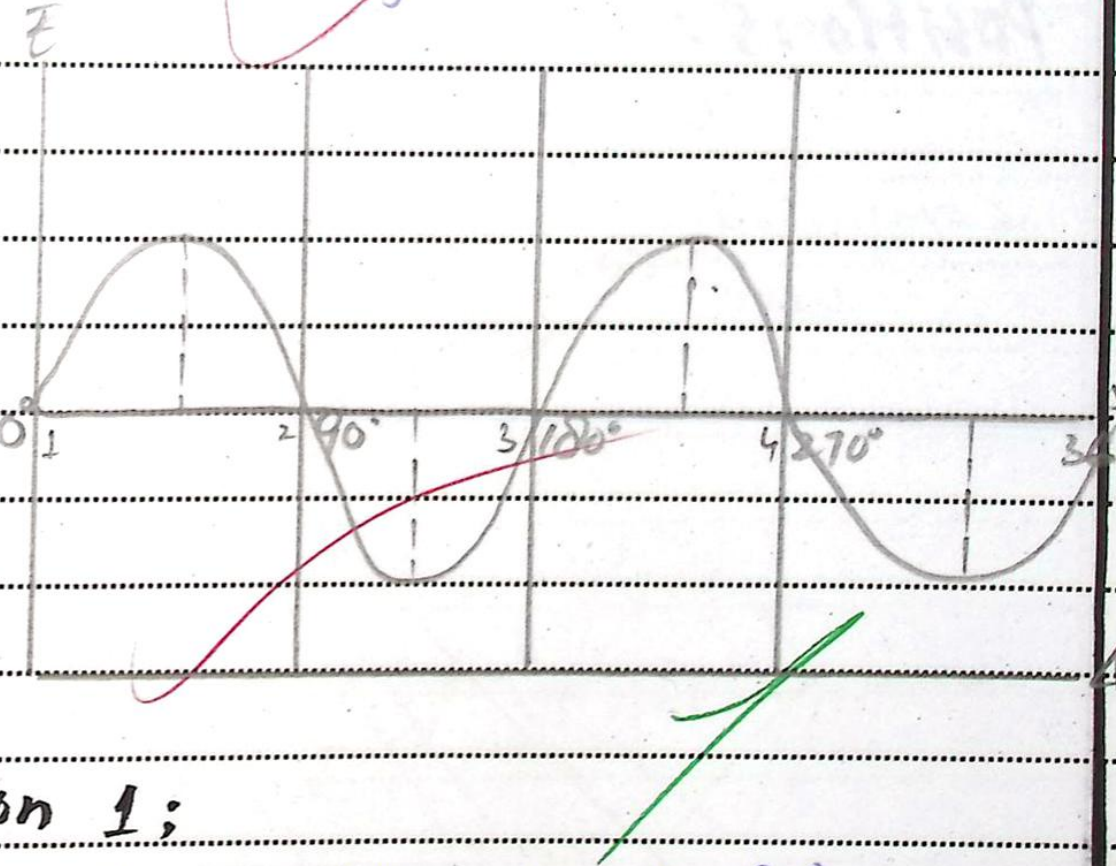
Working:

AC Generator works on the principle of Electromagnetic induction.

The magnetic poles and there is a coil inside which is labled as ABCD at sides which rotates in magnetic field. When magnetic field is provided so the coil rotates due mechinical force provided by magnetic field and the coil starts rotating. after another half turn CD takes the position of AB and vice versa.

At first half turn the position of coil is perpendicular AB is above and CD is below - after another half cycle CD takes the position of AB and viceversa.

In first half cycle the current is from A to B and in another the current is from C to D.



Position 1;

At position 1 $\theta = 90°$

So, current will be zero.

Position 2:

At position 2 $\theta = 90°$ so more current will be produce

Position 3:

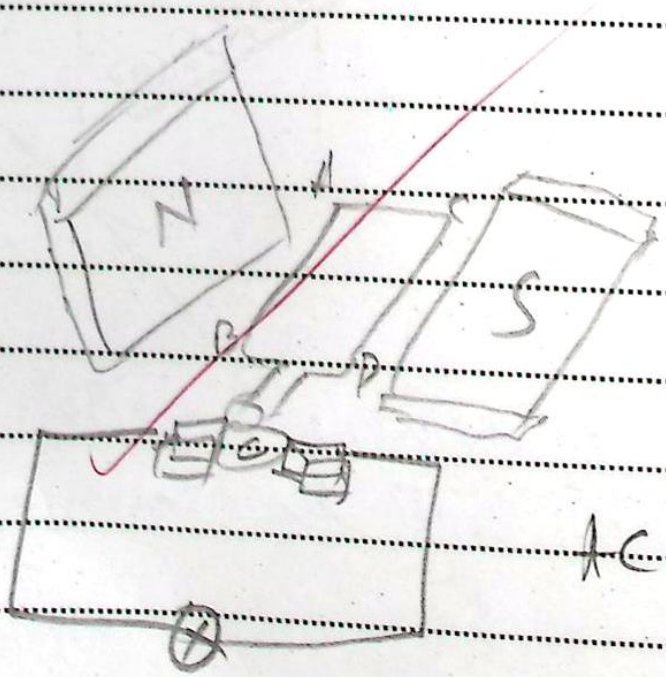
$\theta = 180°$ so, no current will be produced

Position 4:

$\theta = 270°$ so, current will be maximum but negative.

Position 5:

$\theta = 360°$ one cycle is completed and here current is zero.



AC Generator

(b)

Given Data:

$\Delta I = I_f - I_i = 5 - 0 = 5A$

time $= t = 0.1$ sec

Emf induced $= \mathcal{E} = 200V$

Required:

Self inductance $= L = ?$

Solution:

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

So, putting values;

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

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

$$L = \frac{20}{5}$$

$$L = 4 \text{ henry}$$

Or $\boxed{L = 4H}$ Answer.

Question: 4

~~(a)~~ (b)

Given Data:

$n = 4$

Required:

Wavelength $= \lambda = ?$

Solution:

First we find the velocity of electron in n^{th} shell;

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

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

$$V = 546694.069 \text{ m/s}$$

Now using de-Broglie.

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

$$\lambda = \frac{6.62 \times 10^{-34}}{9.11 \times 10^{-31} \times 546694.089}$$

$$\boxed{\lambda = 1.33 \text{ nm}}$$ Answer.

Question: 4

(a)

Answer:

Bohr's postulates about Hydrogen Atoms:

1st postulate:

The electrostatic force of attraction is equal to the centripetal force;

Mathematically;

$$F_c = F_e$$

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

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

2nd postulate:

Angular momentum of electron is the integral multiple of $h/2\pi$.

Mathematically;

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

Where $n = 1, 2, 3 \ldots$ so on.

3rd postulate:

Electron do not radiate energy with in it and it radiate energy while going & jumping from high potential and absorb energy will going from low to high shell.

$$E_1 - E_2 = hf.$$

Expression derivation for radii of electron orbit

By Bohr's 1st postulate;

$$mv^2 = \frac{ke^2}{r} \Rightarrow r = \frac{ke^2}{mv^2} \quad -(1)$$

By Bohr's 2nd postulate;

$$mvr = \frac{nh}{2\pi} \Rightarrow v = \frac{nh}{2\pi mr} \quad -(2)$$

putting Eq ② in Eq ① we get;

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

putting value of v;

$$\frac{Ke^2}{r} \cdot m\left(\frac{nh}{2\pi mr}\right)^2$$

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

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

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

$$h^2 = \alpha = 0.529\text{ Å}$$

$$4\pi ke^2 m$$

Question: 06

(Part: a)

Expression derivation for the capacitance of parallel plate capacitor:

Let;

Let Area of capacitor = A

distance between = d

Capacitance = C

and charge density of σ

Derivation:

As we know that;

$Q = CV$

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

Now

$Q = CV$

Now $Q = \sigma A$ and $V = Ed$

$\sigma A = C(Ed)$

Electric field between the plate $E = \frac{\sigma}{\varepsilon_0}$

$$\Delta K = C\left(\frac{\delta}{\varepsilon_0}\right)d$$

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

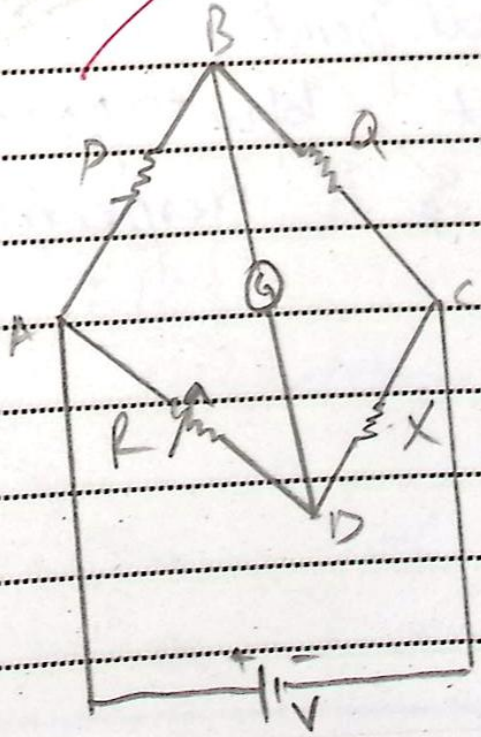
Hence derived.

(Part: b)

Wheat Stone Bridge:

Wheat stone bridge was discovered by Wheatstone in order to find the unknown resistance.

Construction:



Wheatstone bridge consist of 4 resistors P and Q are known resistors having fixed resistance the resistor R has variable resistance and X has fixed resistance but unknown.

A galvano meter is fixed between the point B and D.

When current is provided to the wheatstone bridge the galvano meter shows deflection so, by arranging the variable resistor the resistance is fixed in order to stop the galvanometer to zero known as null point.

The current b/w point P and Q is I_1 & I_2 respectively as

$V = I_1 P$

$V = I_2 Q$

And the current I_1 & I_2 is between R and X

as:

$-V = I_1 R$

$V = I_2 X$

As by taking ratio;

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

to re arranging

$$PX = RQ$$

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

5

So by Wheatstone bridge in this way we can find the resistance of unknown resistance.