SECTION-B

QUESTION. 2:

Part (i)

Given:

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

Required:

$$\vec{E} = ?$$

Solution:

$$\vec{E} = \frac{F}{q_0}$$

$$\vec{E} = \frac{k\frac{q\cancel{q_0}}{r^2}}{\cancel{q_0}}$$

$$\vec{E} = \frac{kq}{r^2}$$

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

$$\vec{E} = \frac{27000}{0.09}$$

$$\vec{E} = 300\,000 \text{ N/C}$$

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Part (ii)

Potential Gradient:

"The rate of change of potential difference with respect to change in displacement is know as Potential Gradient"

Potential Gradient is equal to electric field intensity $(\vec{E})$

i.e: $\vec{E} = -\frac{\Delta V}{\Delta r}$

Mathematically,
We know by the definition of work that

$$\vec{W} = F \Delta r$$

By substituting $F = Eq$,

$$W = Eq \Delta r$$

$$\frac{W}{q} = E \Delta r$$

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

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

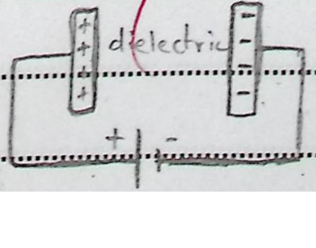
$$\frac{\Delta V}{\Delta r} = \vec{E}$$

or $\vec{E} = -\frac{\Delta V}{\Delta r}$ [-ve sign indicates potential difference is against the field]

Part (iii)

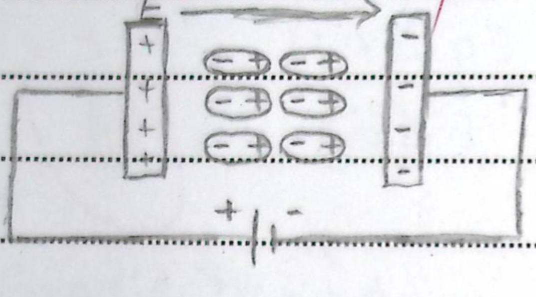
Dielectric:

"The medium between the two plates of a capacitor is known as dielectric."



Dipole:

"When two opposite poles are formed in neutral atom under the influence of electric field, a dipole is formed"



Dipole moment:

"The vector product of charge (q) and distance between dipoles (r) is called dipole moment."

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Polarization:

"The process of forming of dipoles in the dielectric under the influence of electric field is called polarization"

Part (iv)

Volt :

Volt is the unit of potential difference. It is defined as,

" Work done on a unit charge in bringing it from one point to another is called potential difference"

Electron-volt :

Electron-volt is defined as :

" The amount of energy gained or lost by an electron in moving through a potential difference of 1 volt".

Relation:

We can write 1ev as:

$$1ev = 1.6022 \times 10^{-19} C \times 1v$$

$$1ev = 1.6022 \times 10^{-19} J$$

Electron-volt is a very small unit of energy.

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Difference:

Volt is the unit of potential difference while electron volt is the unit of energy.

Part (v)

Ohm's Law:

Ohm's law states that:

"The current flowing through a conductor (I) is directly proportional to potential difference (V)"

Mathematically:

$$I \propto V$$

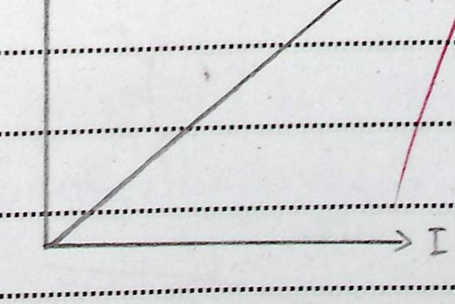
$$I = \frac{1}{R} V$$

$$V = IR$$

Here the proportionality constant is $\frac{1}{R}$ where R is resistance of the conductor.

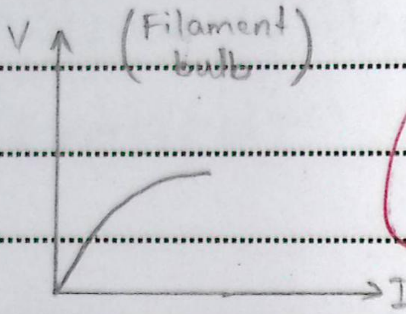
Ohmic substances:

The substances for which IV graph is linear are called ohmic conductors. For example metals.



Non-Ohmic substances:

The substances for which IV graph is curved are called non ohmic substances. For example Filament bulb and thermistor.



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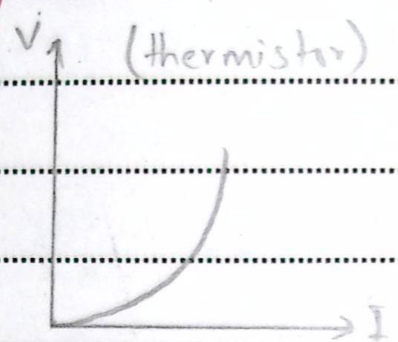

Part (vi)

Inductance:

The emf (ε) induced in a coil due to change in magnetic flux (φ) is called inductance

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We know that inductance is given by

$$L = N\frac{\Delta\phi}{\Delta I}$$

From this equation, we can derive the factors affecting inductance (L).

Factors: 2

Number of turns (N):

Inductance is directly proportional to number of turns

Flux:

Inductance is directly proportional to change in flux.

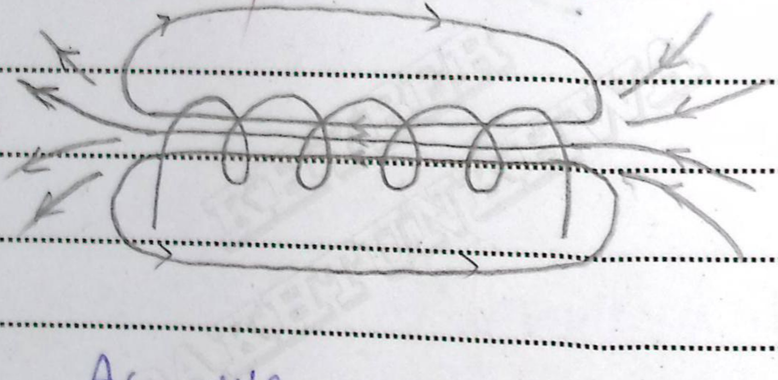
Current:

Inductance is inversely proportional to change in current.

Part (vii)

Magnetic field of coil:

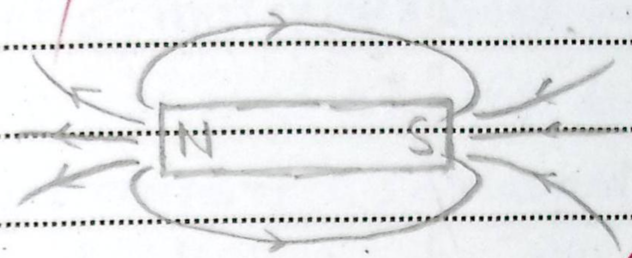
The magnetic field of a current carrying solenoid or coil is concentrated and parralel inside the solenoid but is weak outside it. It can be shown as,



As we can see, on the two ends of solenoid, north and south poles are formed.

Magnetic field of bar magnet:

On the ends of bar magnet, north and south poles are formed. It can be shown as.



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Conclusion:

The magnetic fields of solenoid and bar magnet are similar in nature. So a current carrying solenoid behaves like a bar magnet.

Part (viii)

a) As we know that

$$X_L = 2\pi f_L$$

$$X_L' = 2\pi(2f_L)$$

$$X_L' = 2(2\pi f_L)$$

$$X_L' = 2X_L$$

By doubling the frequency of inductor, its reactance doubles.

b) As we know that,

$$X_c = \frac{1}{2\pi f_c}$$

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

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

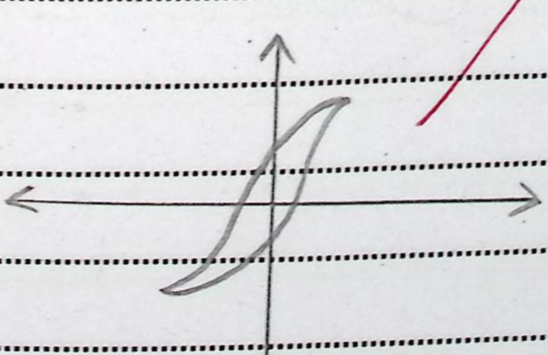
$$X_c' = \frac{1}{2}X_c$$

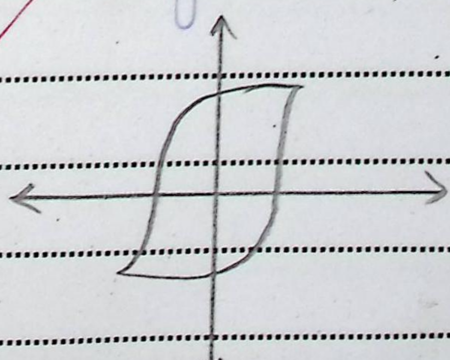
By doubling the frequency of capacitor, its reactance halves.

Part (ix)

Difference:

	Soft magnetic material	Hard magnetic material
i)	**Soft magnetic materials** are easy to magnetize or demagnetize	Hard magnetic materials are difficult to magnetize or demagnetize
ii)	Its hysterisis loop is thin	Its hysterisis loop is thick.
iii)	Its retentivity is small	Its retentivity is huge.
iv)	Its coercive force is small	Its coercive force is huge.





Part (x)

Statement:

Coercive force of steel is greater than iron.

Reason:

Steel is a **hard** magnetic material while iron is a **soft** magnetic material. The retentivity of steel is greater than iron. So its residual magnetism is greater than iron. In order to demagnetize it completely, larger coercive force is required in steel than in iron.

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SECTION-C

QUESTION. 3

Part (a)

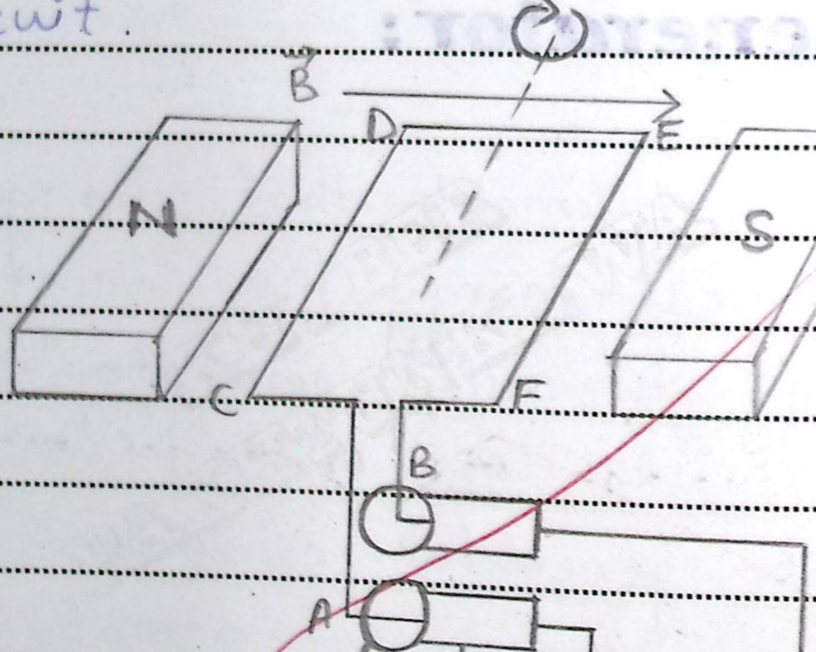
AC Generator:

"An instrument that changes mechanical energy into electrical energy is called generator"

An AC generator converts mechanical energy of armature into Alternating current (AC) emf (E)

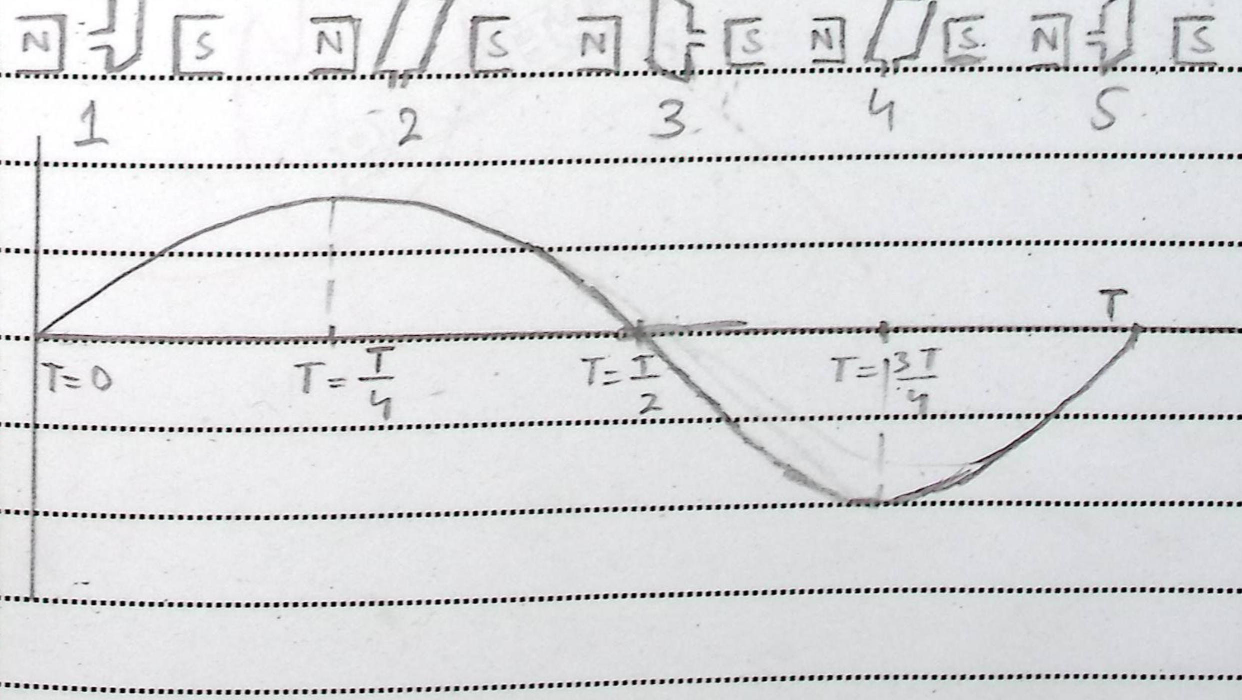
Construction:

Let a rectangular coil known as armature CDEF be present in a magnetic field with two ends A and B attached to slip rings. These slips rings are attached to carbon brushes which are in turn connected to a circuit.



Working:

The DE and CF components of armature are parallel and anti-parallel to the magnetic field. No emf is produced in these parts. By Fleming's right hand rule, emf is induced from C to D and E to F. After half rotation, EF replaces CD. The direction of induced emf reverses like from F to E and D to C. This way induced emf is AC.



At position 1, $\theta = 0^\circ$, so
$\varepsilon = NAB\omega \sin 0^\circ = 0$

At position 2, $\theta = 90^\circ$, so
$\varepsilon = NAB\omega \sin 90^\circ = NAB\omega$

At position 3, $\theta = 180^\circ$, so
$\varepsilon = NAB\omega \sin 180^\circ = 0$

At position 4, $\theta = 270^\circ$, so
$\varepsilon = NAB\omega \sin 270^\circ = -NAB\omega$

At position 5, $\theta = 360^\circ$, so
$\varepsilon = NAB\omega \sin 360^\circ = 0$

Part (b)

Given:

$$\Delta I = 5 - 0 = 5$$

$$t = 0.1\ s$$

$$\varepsilon = 200\ V$$

Required:

$$L = ?$$

Solution:

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

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

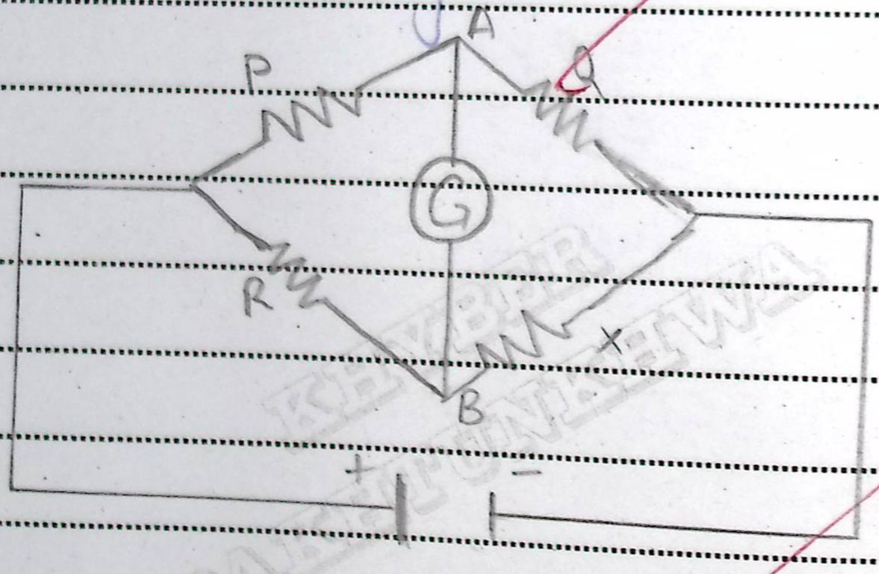
$$L = 4\ H$$

QUESTION: 6:

(b)

WHEATSTONE BRIDGE:

A device used to measure unknown resistance is called wheatstone bridge.



When the bridge is balanced, galvanometer shows zero deflection. This means potential at A and B is same. The potential drop at P and R is same.

$P = V_R I_P$ and $R = V_R I_R$

The potential drop at Q and X is same

$Q = V_X I_P$ and $X = V_X I_R$

$$\frac{P}{R} = \frac{\cancel{V_R} I_P}{\cancel{V_R} I_R} \quad \text{——— (i)}$$

$$\frac{Q}{X} = \frac{\cancel{V_X} I_P}{\cancel{V_X} I_R} \quad \text{——— (ii)}$$

Dividing (i) by (ii)

$$\frac{P/R}{Q/X} = \frac{\cancel{I_P/I_R}}{\cancel{I_P/I_R}}$$

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

$$X = \frac{PQ}{R}$$

5 - 4.5

(c)

Nucleax Fission:

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" The breaking of large nuclei to smaller intermediate nuclei with large release of energy is called nuclear fission."

3.5

Such as uranium-235 breaks into smaller intermediate nuclei

$$\underbrace{{}^{1}_{0}n + X}_{\text{original nucleus}} \longrightarrow \underbrace{X^{*}}_{\substack{\text{intermediate} \\ \text{(excited state)}}} \longrightarrow \underbrace{Y + P}_{\text{new nuclei}} + \underset{\text{energy}}{Q}$$

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CONTINUATION SHEET

Fic. No. V175

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QUESTION. 4:

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Bohr's postulates:

(i) electrons revolve around the nucleus in fixed circular path centripetal force is provided by coulombic force between electron and nucleus.

$$\frac{mv^2}{\cancel{r}} = \frac{kq_1q_2}{r^{\cancel{2}}}$$

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

ii) electrons must revolve in a specific and allotted path called energy levels with angular momentum $\frac{h}{2\pi}$

iii) When electron jump from high energy level to lower energy level they radiate energy and vice versa

$$\Delta E = E_2 - E_1$$

Derivation of radius:

$$F_c = F_{coulomb}$$

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

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

$$v^2 = \frac{ke^2}{rm} \quad \text{——} \ (1)$$

From Bohr's II - postulate

$$v = \frac{nh}{m2\pi r} \quad \text{——} \ (2)$$

Put (2) in (1)

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

+)

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

$$\boxed{r_n = \frac{n^2h^2}{4\pi k m e^2}}$$

(b)

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

$$\frac{1}{\lambda} = 1.097\times10^7\left(\frac{1}{(3)^2} - \frac{1}{(4)^2}\right)$$

$$\frac{1}{\lambda} = 1.097\times10^7\left(\frac{1}{9} - \frac{1}{16}\right)$$

$$\frac{1}{\lambda} = 1.097\times10^7 \times 0.05$$

$$\frac{1}{\lambda} = 0.054\times10^7$$

$$\frac{1}{\lambda} = 5.4\times10^5$$

$$\lambda = 1.85\times10^{-6}\ m$$