SUBJECTIVE-TYPE

SECTION - B

QUESTION - 2

SHORT ANSWERS

(ix)

DIFFERENCE B/W SOFT & HARD MAGNETIC MATERIALS

SOFT MAGNETIC MATERIAL:

Materials with narrow magnetic hysteresis loop are easily magnetized & demagnitized and are called soft magnetic materials.

EXPLANATION:

Soft materials have narrow hysteresis loop: thus; they posses small amount of residual magnetism and to overcome less coercive force is required.

HARD MAGNETIC MATERIALS:

DEFINITION:

Materials with broad magnetic hysteresis loop are difficult to magnitize & demagnetized and are called hard magnetic material.

EXPLANATION:

Hard materials have fat hysteresis loop, thus they posses large amount of residual magnetism and to over large coercive force is required

(V)

OHM's LAW:

STATEMENT:

The magnitude of the current in a conductor is proportional to the applied voltage as long as the temperature of the conductor is kept constant.

MATHEMATICAL FORM:

$$I \propto V$$

$$I = KV \quad \text{i.e } K = \frac{1}{R}$$

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

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

$$V = IR$$

OHMIC CONDUCTOR:

A conductor which obeys Ohm's law strictly is called

Ohmic conductor

EXAMPLE: Metals are ohmic conductors

NON- OHMIC CONDUCTOR:

These are devices which do not obey Ohm's law, are called as non-ohmic conductor.

EXAMPLE: Filament of bulb (tungsten), thermistor and semiconductor diode.

(X)

QUERY:

Coercive force of steel is greater than iron.

REASON AND EXPLANATION:

COERCIVITY:

The intensity of the applied

magnetic field required to reduce the magnetization of a given material to zero is known as coercivity.

RETENTIVITY:

The capacity of an object to retain magnitism after the action of the magnetizing force has ceased is known as retentivity.

COMPARISON OF STEEL WITH IRON:

From the hysteresis loop given in the figure, it is clear that coercive force required to demagnetized steel is greater than soft iron, whereas retentivity of steel is slightly less than soft iron.

CONCLUSION:

Since materials with greater coercivity are used as permanent magnet. therefor steel is also used for making permanent magnets

(iv)

VOLT:

The term volt represents unit of potential difference and 1 volt is the potential difference when one joule of work is done in moving 1 coulomb charge between two points against electric field.

ELECTRON VOLT:

Electron - volt (eV) is the unit of energy and 1 eV is the kinetic energy gained or lost by an electron when it moves through a p.D of 1 volt.

RELATION:

The energy E in electron - volts wt is equal to the voltage V in volts times the electric charge Q in elementry units (e)

$$E_{(eV)} = V_{(V)} \times Q_{(e)}$$

Thus 1 eV energy is equivalent to,

$$1\ eV = 1\ V \times 1\ e$$

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

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

$$\because V \times C = J$$

DIFFERENCE:

Volt and electron - volt (eV) are two different physical quantities. Electric potential is a property associated with the field, while the energy is associated with the particle you place into that field and it depends on the particle

(VIII)

a) Doubling the frequency doubles the inductive reactance:

EXPLANATION:

As inductive reactance X_L is given by the following equation

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

Now by doubling the frequency the new reactance is:

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

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

$$X_L' = 2X_L$$

b) Capacitive reactance becomes half when frequency is doubled:

EXPLANATION:

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

By doubling the frequency f, the new reactance is ;

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

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

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

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

(Xi)

BETA - FACTOR:

The ratio of collector current i_C and base current i_B is called as beta factor. That is :

$B_{static} = \frac{i_C}{i_B}$ and

$$\beta_{dynamic} = \frac{\Delta i_c}{\Delta i_B}$$

The beta factor is called as current gain or current amplification factor.

Generally it ranges from 50 to 400. We can write.

$$\beta = \frac{i_c}{i_B}$$

$$\beta = \frac{i_c}{i_E - i_c}$$

$$\beta = \frac{\frac{i_c}{i_E}}{\frac{i_E - i_c}{i_E}}$$

$$\beta = \frac{\alpha}{1 - \frac{i_c}{i_E}} \quad \text{since } \frac{i_c}{i_E} = \alpha$$

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

(i)

GIVEN:

Radius $= r = 30\ cm = 3.0 \times 10^{-2}\ m = 0.3\ m$

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

REQUIRED:

electric field $= E = ?$

SOLUTION:

Using electric field intensity formula:

$$E = \frac{1}{4\pi\varepsilon_0} \frac{q}{r^2}$$

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

$$= 3 \times 10^{5}\ NC^{-1}$$

(ii)

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

work done on test charge = force x distance moved

$$\Delta W = F \cdot \Delta r \rightarrow 1$$

In an electric field, the force acting is equal to the charge times the field strength.

$$F = q_0 E$$

$$\text{work done} = \Delta W = E q_0 \Delta r$$

Using (1) we have

$$\Delta W = -q_0 \Delta V$$

The negative sign is applied because the work done q_0 is against field force $q_0 E$ so

$$q_0 \Delta V = -E q_0 \Delta r$$

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

The strength of the field is equal to the potential gradient.

(vii)

QUERY:

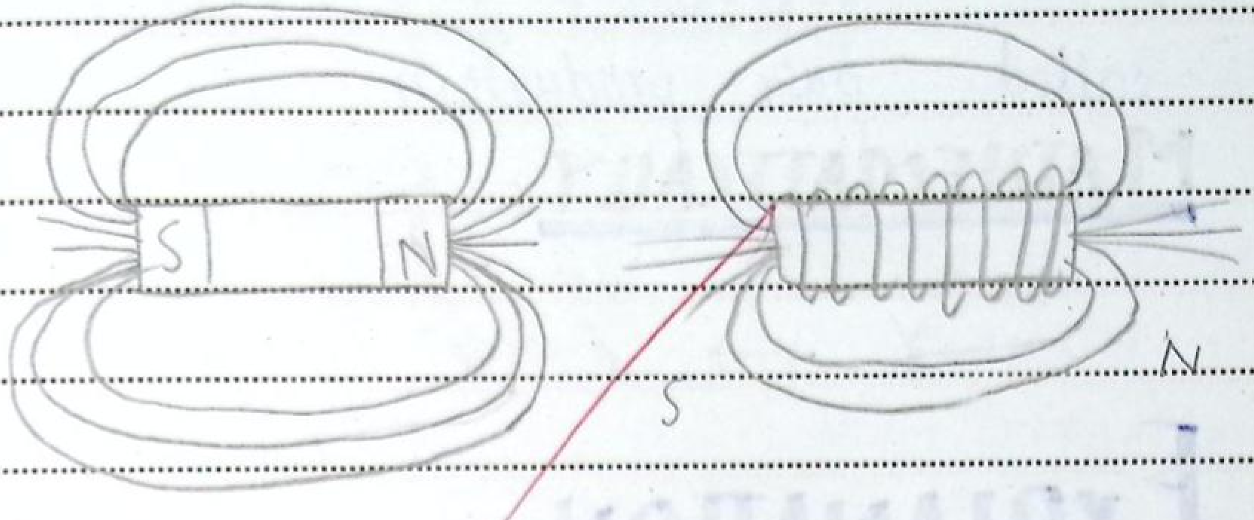
A current carrying coil behave like a bar magnet.

REASON & EXPLANATION:

A bar magnet has a definite north & south pole as shown in the figure below. When current passes through a coil, magnetic field is set up around it.

Direction of field can be determined by right hand rule which state that.

Imagine to hold the solenoid in right hand with fingers curling in the direction of the current



Bar magnet Current carrying coil.

(Xiii)

PAIR PRODUCTION:

DEFINITION:

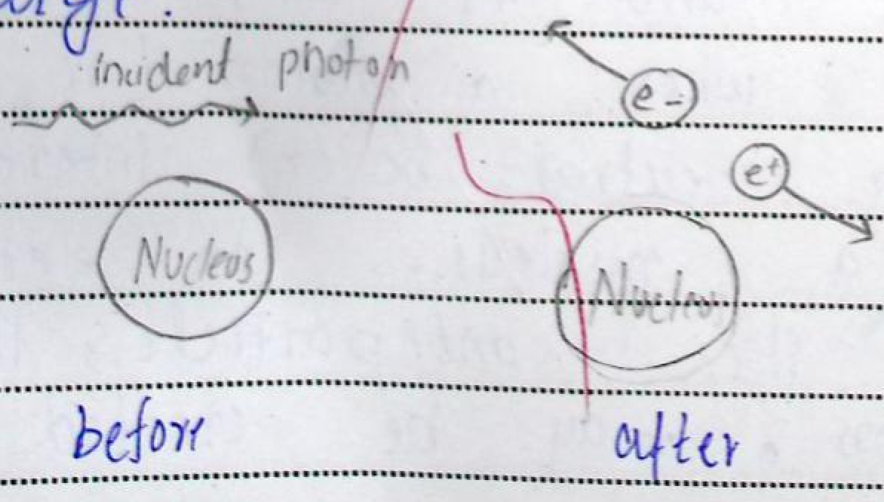
The creation of an elementary particle and its antiparticle, usually when a photon (or another neutral boson) interacts with a nucleus, an electron and its antiparticle, the positron, may be created is called pair production.

MATHEMATICALLY:

$$\gamma \longrightarrow e^- + e^+$$

EXPLANATION:

Pair production is the process in which a photon is converted into matter in accordance with Einstein equation $E = mc^2$. A photon when passes near a nucleus it disintegrates into electron and positron pair. Positron has the same mass as electron but opposite charge.



ENERGY OF PHOTON:

In order to create an electron positron pair, a minimal of $2m_oc^2$ is needed the surplus energy is taken by electron and positron as their kinetic energies.

MATHEMATICCALY:

$$hf = 2m_oc^2 \mp (KE)_{-e} + (KE)_{+e}$$

SECTION - C

QUESTION - 6

(a)

Expression for the Capacitance of a parallel plate Capacitor:

Consider a parallel plate capacitor connected to a battery the plates get charging till the potential between plates become 'V' equal to potential of the battery Let one plate get +Q charge then the other plate will get −Q charge. If the positive plate is at potential V_1 and negative plate is at potential V_2, the the electric field strength between the plates is :

$$E = \frac{\Delta V}{\Delta r} = -\frac{(V_2 - V_1)}{d} = \frac{V_1 - V_2}{d}$$

$$= \frac{V}{d}$$

$$E = \frac{V}{d} \rightarrow (1)$$

where $V = V_1 - V_2$ is the potential difference and d is the separation between the plates. The strength of the electric field also depends on the number of charges on the plates. The charge density is the total charge per unit area of the plate i.e.

$$\sigma = \frac{Q}{A}$$

By using Gauss's law, the electric field intensity E between the plates is give by:

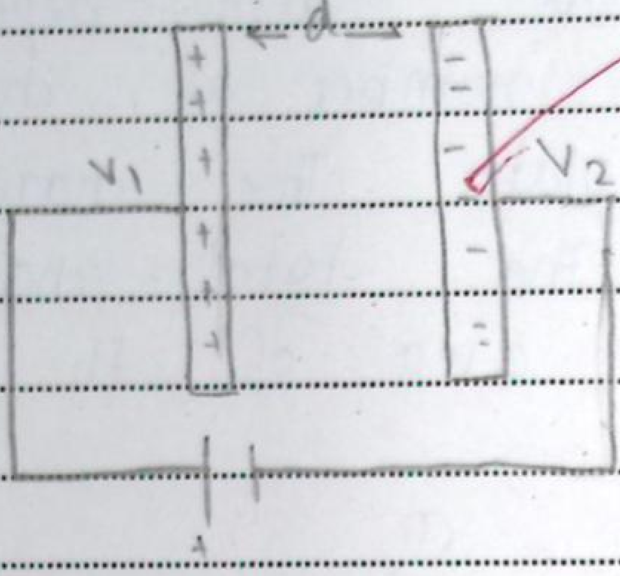
$$E = \frac{\sigma}{\varepsilon_0} = \frac{Q}{A\varepsilon_0} \rightarrow (2)$$

From Eq. (1) & (2);

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

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

$$C_{vac} = \frac{A\varepsilon_0}{d}$$



(C)

NUCLEAR FISSION:

DEFINITION:

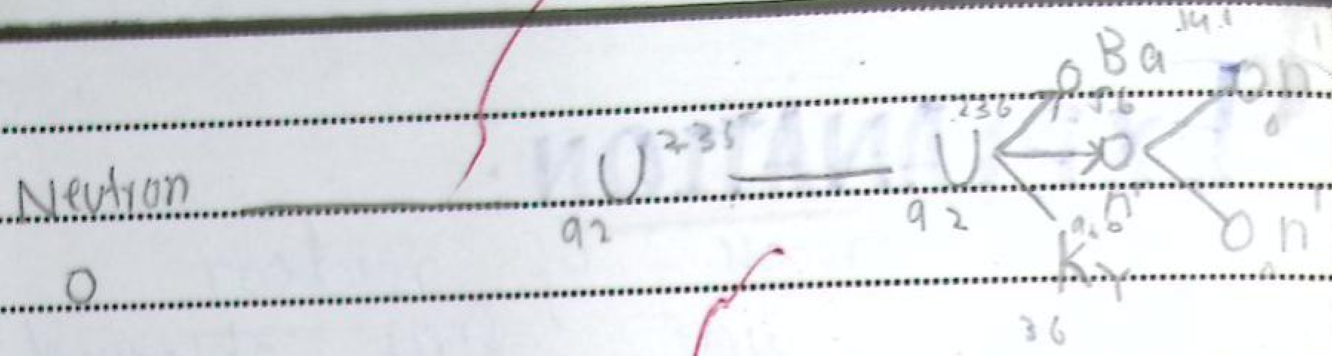
It is a special type of nuclear reaction in which a heavy nucleus splits up into two nuclei with the emission of tremendous amount of energy.

EXPLANATION:

The process of nuclear fission was first observed by Hahn in 1939.

The fission process is produced when sufficient energy is given to the target nucleus by bombarding certain particle like neutron, proton, deutron or γ- ray photon etc.

Generally $_{92}U^{235}$ is used for the fission process. It is because, for the fission of $_{92}U^{235}$ we need fast neutron of energy 1 MeV. Now consider a slow neutron of energy is allowed to fall on $_{92}U^{235}$ as shown in the figure



when the neutron enters into the nucleus of $_{92}U^{235}$, a compound nucleus $_{92}U^{236}$ is formed. This compound nucleus is unstable and disintegrates into two fragments $_{56}Ba^{141}$ and $_{36}K^{92}$ with the release of huge amount of energy

$$_{0}n^{1} + {}_{92}U^{235} \longrightarrow [{}_{92}U^{236}] \longrightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + 3\,{}_{0}n^{1} + Q$$

QUESTION-3

(a)

AC - GENERATOR:

8

DEFINITION:

The device which converts mechainical energy into electrical energy of the form in which the flow of electric charges periodically reverses direction.

CONSTRUCTION:

The AC generator consists of the following parts

1- **ARMATURE:**

It is a rectengular coil which is placed between the poles of a magnet.

2- **FIELD MAGNET:**

The field magnets are

used to produce a uniform magnetic field

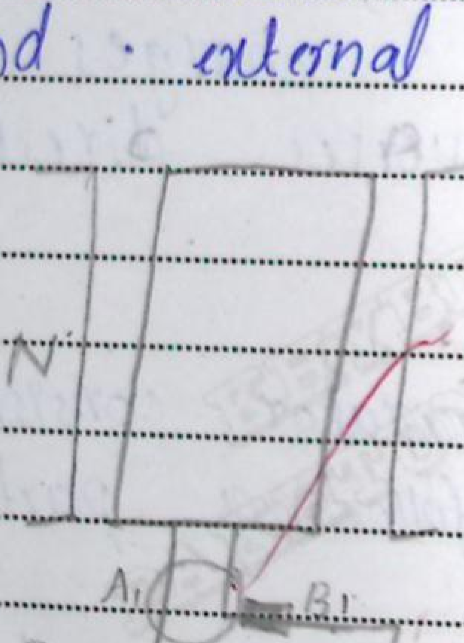
3- **SLIP RINGS:**

The slip rings are in contact with coil. It can rotate with armature.

4- **CARBON BRUSHES:**

The carbon brushes are in contact with slip rings and external circuit.

Diagram



WORKING:

When the side CD

moves upwards, Fleming's Right hand rules shows that the direction of the current is from C to D.

When the coil rotates, the magnetic flux linking the coil changes. The changing magnetic flux causes an indused current.

5

$$\Phi = B \cdot A$$

$$\Phi = BA \cos\theta \rightarrow 1$$

For N-number of turns

$$\Phi = NBA \cos\theta \rightarrow 2$$

According to forady's law:

$$\varepsilon = -\frac{\Delta\Phi}{\Delta t} \rightarrow 3$$

From equation 2 & 3

$$\varepsilon = -\frac{\Delta}{\Delta t}[NBA \cos\theta]$$

$$\varepsilon = -\frac{\Delta}{\Delta t}[NBA \cos(wt)]$$

$$\varepsilon = -NBA\frac{\Delta}{\Delta t}\cos(wt)$$

$$\varepsilon = -NBA(-w\sin wt)$$

$$\varepsilon = NBA\,w\sin(wt)$$

(b)

GIVEN:

Initial current, $I_i = 5A$

Final current, $I_f = 0A$

Change in current, $\Delta I = 0A - 5A$

$= -5A$

Time taken, $\Delta t = 0.1s$

Indused e.m.f, $\varepsilon = 200V$

REQUIRED:

Self inductance, $L = ?$

SOLUTION:

Since the self inductance is given by:

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

$$L = -\frac{200\ V \times 0.1\ s}{-5\ A}$$

$$L = \frac{20\ V \times s}{5\ A}$$

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

QUESTION - 4

(a)

POSTULATES OF BOHR'S MODEL ABOUT HYDROGEN ATOM:

The basic postulates of the Bohr model of the hydrogen atom are as follows:

1- The electron moves around the nucleus in a circular orbit. The centripetal force required to keep the electron in the circular orbit is provided by the coulomb force between the positively charged nucleus and negatively charged electron.

MATHEMATICALLY:

$$F_{centripetal} = F_{coloumb}$$

$$F_{centripetal} = \frac{mv^2}{r} \longrightarrow 1$$

$$F_{coulomb} = K\frac{q_1 q_2}{r^2} \longrightarrow 2$$

Combining Eq 1 & 2:

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

2- 2- An electron cannot revolve around the nucleus in

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any arbitrary circular orbit Only those orbits are possible for which the angular momentum is the integral multiple of $h/2\pi$.

MATHEMATICALLY:

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

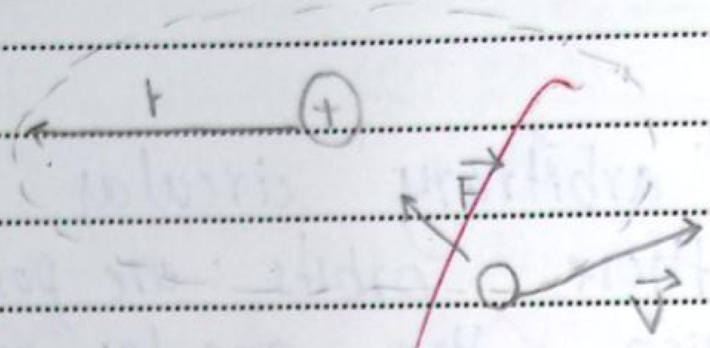
$$mvr = \frac{nh}{2\pi}$$

3- The electron in stable orbit does not radiate energy as in the classical theory.

MATHEMATICALLY:

$$E = E_n - E_p$$

$$hf = E_n - E_p$$



THE RADII OF THE QUANTIZED ORBIT

From Bohr's model 2nd postulate, we know that:

$$mvr_n = n\frac{h}{2\pi}$$

$$v = \frac{nh}{2\pi m r_n} \longrightarrow 3$$

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

$$mv^2 = \frac{ke^-}{r_n^2} \times r_n$$

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

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

$$m\left[\frac{n^2h^2}{4\pi^2 m^2 r_n^2}\right] = \frac{ke^2}{r_n}$$

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

$$r_n = \frac{n^2h^2}{4\pi^2 kme^2}.$$

(b)

GIVEN:

Principal quantum number, $n = 4$

Bohr Radius, $r_0 = 0.53 \times 10^{-10}$ m

Number, $\pi = 3.14$

REQUIRED:

Wave length associated with electron, $\lambda = ?$

SOLUTION:

For calculating wavelength, we use de-Broglie equation, i.e

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

Also from 2nd postulate of Bohr's atomic model, we have:

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

$$mv = \frac{nh}{2\pi r_n} \longrightarrow (2)$$

Putting the value from Eq (2) in Eq (1) we get

$$\lambda = h \div \frac{nh}{}$$

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$$\lambda = h \times \frac{2\pi r_n}{nh}$$

$$\lambda = \frac{2\pi r_n}{n} \rightarrow 3$$

From quantization of radii

$$r_n = n^2 r_o$$

$$\lambda = \frac{2\pi n^2 r_o}{n} = \frac{2\pi n^2 r_o}{n}$$

$$\lambda = 2\pi n r_o$$

$$\lambda = 2 \times 3.14 \times 4 \times 0.53 \times 10^{-10} m$$

$$\lambda = 1.33 \times 10^{-9} m$$

$$\boxed{\lambda = 1.33 nm}$$