Q. No. 2 (i) SAFE TO STAY INSIDE AN AUTOMOBILE

It is safe to stay inside an automobile during a storm because as we know automobile is made ~~of~~ of metal and metal is a conductor. So as we know inside the conductor

$\Phi_E = \frac{Q}{\varepsilon_o} \rightarrow i)$

$Q = 0$ so flux $\Phi_E = 0$ so also we know that

$\Phi_E = (\emptyset) EA \rightarrow ii)$

from i) and ii)

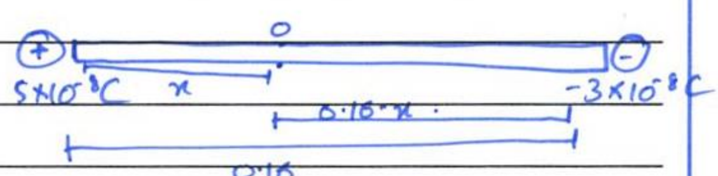
$EA = \frac{Q}{\varepsilon_o}$ $\quad EA = 0$

since $A \neq 0$ so $E = 0$

electric field inside the conductor is zero. So when there will be a storm. no electric field will pass through the car and will protect us from ~~scho~~ shock.

Q. No. 2 (ii)

Data:-



$Q_1 = 5\times10^{-8}\,C = V_1$

$Q_2 = -3\times10^{-8}\,C = V_2.$

$d = 16cm = 0.16\,m.$

let O be a point where electric potential is zero so let distance of charge Q_1 from O is x and Q_2 from O is $0.16-x$.

now Electric potential = 0

$|V_1| + |V_2| = 0$

$\frac{KQ_1}{r_1} + \frac{KQ_2}{r_2} = 0$

$Q_1 r_2 = -Q_2 r_1$

$(5\times10^{-8})(0.16-x) = -(-3\times10^{-8})(x)$

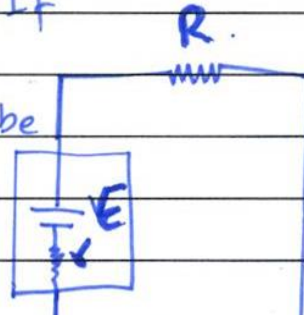
$8\times10^{-9} - 5\times10^{-8}x = +3\times10^{-8}x$

$8\times10^{-9} = 3\times10^{-8}x + 5\times10^{-8}x$

Q. No. 2 (iii)

Q. No. 2 (iv) **Maximum Power transfer**

Maximum transfer of power will be there if the resistance of the source / battery (internal resistance) will be equal to the resistance of the load. If resistance ~~(power)~~ is less or more than internal resistance power will be minimum



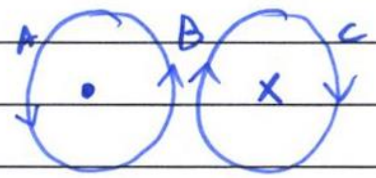
now as $I = \frac{E}{R+r}$

$P = I^2R = \left(\frac{E}{R+r}\right)^2 R = \frac{E^2 R}{R^2+r^2+2rR}$

$P = E^2R$

Q. No. 2 (v) **Two straight wires carrying current in opposite direction**

The two straight current carrying wires carrying current in opposite direction will **repel** each other. Consider two wires carrying current in opposite direction



Since in two wire carrying current in opposite direction the field will be stronger at point B so since force acts from high field to low field so magnetic force ($F = ILB\sin\theta$) will act from B to A and B to C as a result wires will repel.

Q. No. 2 (vi) **Galvanometer:-**

A Galvanometer is a device used for the detection and for measuring of small amount of currents. It can be converted into ammeter and voltmeter by combining them in parall or series. Its principal is torque on current carrying coil.

Numerical

Data:- $I_g = 5mA = 5\times10^{-3}A$, $R_g = 100\Omega$ $V = 20V$

$R_h = ?$ Formula = $R_H = \frac{V}{I_g} - R_g$

$$R_H = \frac{20}{5\times10^{-3}} - 100$$

Q. No. 2 (vii)

Q. No. 2 (viii) Second Postulate of Bohr's Model Based upon De-broglie's.

Second Postulate:-

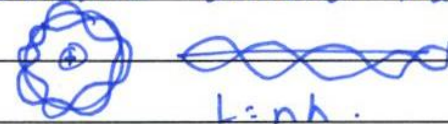
The orbitals of electrons are quantized. Only those orbitals are possible in which angular momentum is integral multiple of $\frac{h}{2\pi}$

$mvr = \frac{nh}{2\pi}$ where $n = 1, 2, 3 \ldots$

Prove:-

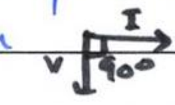
According to debroglie $\lambda = \frac{h}{p}$, $\lambda = \frac{h}{mv} \rightarrow 1$

now electrons revolve around the nucleus in form of wave so



$L = n\lambda$.

Q. No. 2 (ix) In case of an ideal capacitor power loss is zero. now for this consider a capacitor (pure) connected to AC source. Capacitor opposes the change of **voltage** so it lags behind **current** by 90°. now consider



$I = I_m \cos \omega t \; / \; I_m \sin(\omega t + \pi/2)$ $\quad V = V_m \sin \omega t$.

In case of capacitor

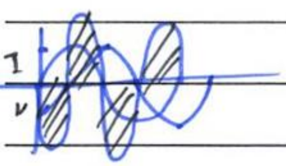
Power consume: $P = VI$

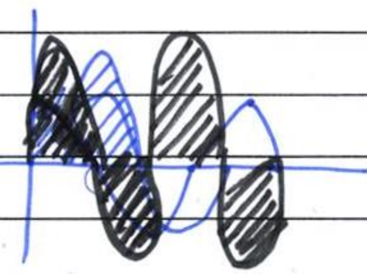
$= (I_m \cos \omega t)(V_m \sin \omega t)$

$= I_m V_m \langle \cos \omega t \rangle \langle \sin \omega t \rangle$

$= I_m V_m (0)$

$= (0)$



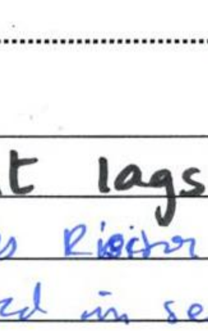


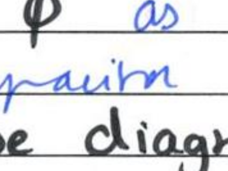
So power consumed is zero. Positive power = negative power

Q. No. 2 (x) **RL- Series**

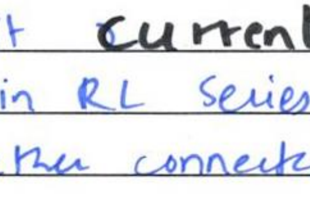
In RL Series circuit **current lags voltage** by ϕ as we know in RL Series Resistor and capacitor are together connected in series so.

Phase diagram





now



$V = \sqrt{V^2 + (VX_L)^2} = \quad V = I\sqrt{R^2 + (X_L)^2}$

now since

08

The relevant question should be answered only in the allotted space and inside the outer mark

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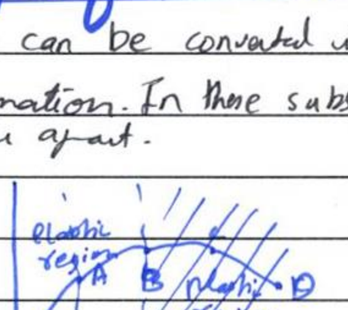
Q. No. 2 (xi)

PARAMAGNETIC	DIAMAGNETIC	FERROMAGNETIC
The substance in which orbital and spin motion of electron support each other are called paramagnetic	The substances in which orbital and spin motion of electron cancel each other. are called diamagnetic	The indivual atoms acts like tiny magnets. They cantain domains which allign themselves in absence of magnetic field
They are weakly attracted towards magnetic field	They are weakly repelled by magnetic field.	They are strongly attracted in magnetic field.
Antimony, Almunium	Copper, Tin, Zinc	Iron, Cobalt, Nickel
In absence of magnetic field. In presence of magnetic field N S	In absence of magnetic field In presence of magnetic field	In absence of magnetic field In presence of magnetic field

Q. No. 2 (xii) Stress strain Graph for ductile materials

Ductile materials are those that can be converted into sheets of wire. They undergo deformation. In these substance UTS and fracture point are far apart.

Stress Strain Curve



from OA to A Hooks law is valid. Strain ∝ stress. Stress It is called elastic region.

from A to B Although hooks law is not valid but body is in its elastic region.

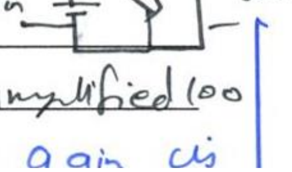
The ~~A~~ point B is called yeild point. and stress is called yeild strength σ. Now if force is incread beyond point B. the body (ductile) will undergo plastisity

Q. No. 2 (xiii)

....

Q. No. 2 (xiv) **Transistor as Current Amplification**

In case of transistor either current, voltage or both are Amplifies. In common base voltage is amplified. In common collector current is amplified and in common emitter both the current and voltage are amplified as a result output power is greatly increas. As a result most commonly common emitter is used for current Amplication. now since for common emitter current gain.



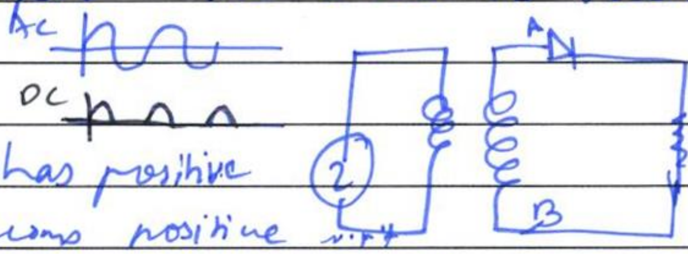
$\beta = \frac{I_C}{I_B}$ $\quad I_C = \beta I_B$

if $\beta = 100$ it shows base current is amplified 100 times then the base current. The current gain is

Q. No. 2 (xv) PN Junction diode as Half wave Rectifier:-

A half water rectifier is a semi-conductor diode/rectifier which converts only half wave of AC into DC is called half wave rectifier. It consists of only one diode. A transformer is used to couple the source to rectifier.

now



At first:-

when the AC has positive half cycle A becoms positive B so current passes through diode. It is forward baised. In negative half cycle no current passes through diode. as it is reverse baised.

Q. No. 2 (xvi) To prove $\beta = \frac{\alpha}{1-\alpha}$

As we know current gain of common base is

$\alpha = \frac{I_C}{I_E}$ →i)

now current gain of common emitter is

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

~~(now taking Ic common from sum)~~

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

$\quad I_E - I_C = I_B$

$B = I_C \left(\frac{1}{} \right) = \frac{1}{} = \frac{1}{}$

Q. No. 2 (xvii)

Q. No. 2 (xviii) For 2nd line of Paschen series

as we know

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

for paschen series $p = 3$ and for second line $n = 3+2 = 5$

now

$R_H = 1.09678 \times 10^7 m$

now

$$\frac{1}{\lambda} = 1.09678 \times 10^7 \left[\frac{1}{(3)^2} - \frac{1}{(5)^2}\right]$$

$$= 1.09678 \times 10^7 \left[\frac{1}{9} - \frac{1}{25}\right]$$

$$= 1.09678 \times 10^7 [0.071]$$

$$\frac{1}{\lambda} = 779932.4 \, m^{-1}$$

$\lambda = 1.282 \times 10^{-6} m$ or $1282 \, nm$.

Q. No. 2 (xix) factors affecting fusion

In fusion reactions, smaller nuclei combine to form a large nuclei. So when smaller nuclei combine repulsive forces operate between them and energy / temperature of about 10^8K is required to overcome these forces so it is difficult to attain such a **high temperature**. Also when gases / solids or atoms are given such a high temperature they convert into **plasma** so it is difficult to design such apparatus in which plasma can be placed. Thus It cannot be placed in ordinary **chambers**. Also fusion reaction requires **large amount of energy / heat** to start which occurs only in stars or sun etc So it is difficult to acheive fusion reaction.

Q. No. 2 (xx)

$^{234}_{90}Th \rightarrow ^{234}_{91}Pa + ^{0}_{-1}B$

Th = 234.0436u

Mass of Pa = 234.0428 u.

$^{0}_{-1}B$ = 0.00055u

now

Total mass on L.H.S

mass of Th = 234.0436 u.

R.H.S (mass)

234.0428 + 0.00055

= 234.04335.

L.H.S − R.H.S = mass ~~def~~ difference

234.0436 − (234.04335)

$= 2.5 \times 10^{-4}$ u

now $E = 931.5\,MeV \times 2.5 \times 10^{-4}$ u

~~= 0.0~~

= 0.232 MeV ✓

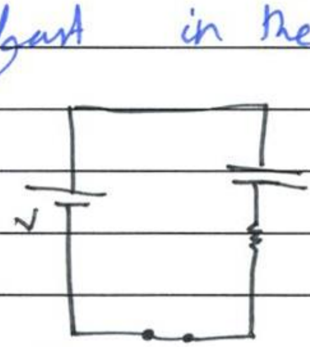
Q3

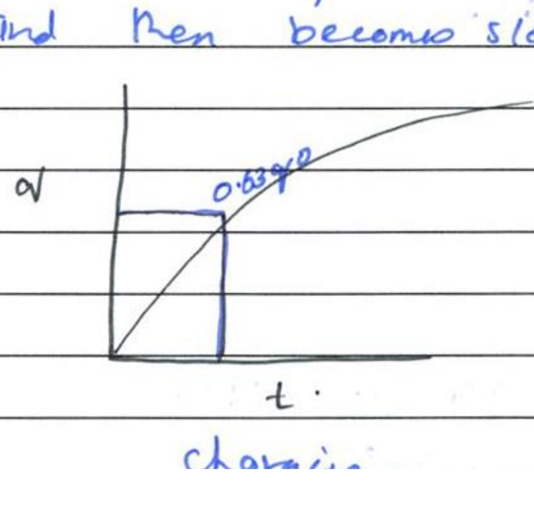
(a)

Charging and Discharging

Consideration:-

Consider an capacitor is connected to a battery, a key and resistance r. In the beginning when the key is open the initial conditions are I = 0 q = 0 t = 0 r = 0 now the switch is closed and the current start passing through the circuit the capacitor starts **charging**. let at any instant of time q be the charge stored on the capacitor. we see that as the ~~(current through)~~ charge on capacitor increase current decrease due to repulsive force. now we see at a particular time t = RC the capacitor is charge 0.63 % of its maximum value. The charge on the capacitor increase fast in the start and then becomes slow.





Q. No. 3 (Page 2/6) capacitor is called time constant. At t=RC capacitor is charge 63% of its maximum value now maximum charge on capacitor = (emf of battery) x (capacitance)

now
for charging

$q = q_0(1-e^{-t/RC})$

when t = RC so

$q = q_0(1-e^{-RC/RC})$

$q = q_0(1-\frac{1}{e})$

$q = q_0(0.63)$

$= 63\% \, q_0$.

now when t = -2RC.

$q = q_0(1-e^{-t/RC})$

$= q_0(1-e^{-2})$

$= q_0(1-\frac{1}{e^2}) = 83\% \, q_0$.

Discharging

The time during which charge on capacitor is 36.8% of its maximum value is called discharging time constant.

now the battery is removed and key is close. now the capacitor will start to discharge now when t=RC

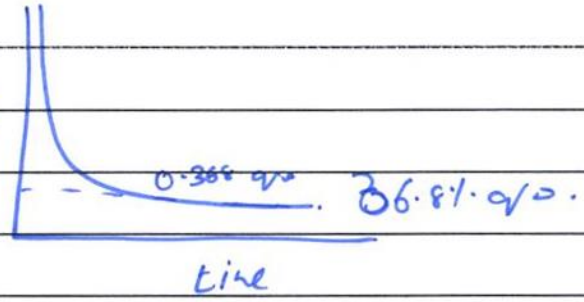
amount of (capacitance) on charge on capacitor

$q = q_0(e^{-t/RC})$

when t = RC

Q. No. 3 (Page 3/6)

Charging and discharging are used in integrated circuits in autom. In Ignition circuits in automobile, rails etc.



Q3

(b)

Amperes law:-

Amperes law interelates the current passing through a current carrying conductor to magnetic field.

The Sum of length elements multiplied by the magnetic field B is directly proportional to the current flowing through the current carrying coil.

$B \propto I$ $B \propto \frac{1}{r}$ $B = \frac{\mu_0}{2\pi}\frac{I}{r}$ $\sum B \cdot \Delta L = \mu_0 I$

When $\mu_0 = 4\pi \times 10^{-7}$ Tm/A.

Magnetic field due to Solenoid

A wire wound in the form of helix is called solinoid. When current passes

Q. No. 3 (Page 4/6) pole. In loosly bound solinoid.
field in uniform in the interion.
Idial solenoid is the one in which loops
are tighty bound and is of large size
so that magnetic field inside is ~~zero~~
maximum and outside is zero.

Consideration :-
consider a current carrying solinoid.
Amperes loop is in the form of
rectangle having lengths l_1, l_2, l_3 and
l_4 respectively. Now According to
Amperes law

$\Sigma B \cdot \Delta l = \mu_o I$

now

$Bl_1 + B \cdot l_2 + B \cdot l_3 + B \cdot l_4 = \mu_o I.$

$= Bl_1 \cos\theta_1 + Bl_2 \cos\theta_2 + Bl_3 \cos\theta_3 + Bl_4 \cos\theta_4 = \mu_o I.$

since

$\cos\theta_1 = 0°, \theta_2 = 90° \quad \theta_3 = 180°$ and $\theta_4 = 270°$

$Bl_1 \cos 0 + Bl_2 \cos 90 + Bl_3 \cos 180° + Bl_4 \cos 270 = \mu_o I$

since l_3 is outside the solinoid and
outside solenoid $B = 0$

$Bl_1 = \mu_o I$

$Bl = \mu_o I$

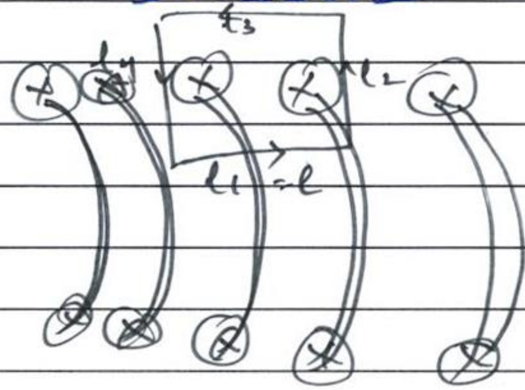
if N is number of turns in solinoid
then

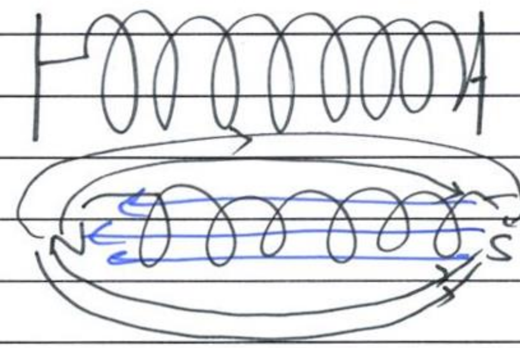
$Bl = \mu_o N I.$

$B = \mu_o N I$

where n is number of turns per length so ~~inside~~ solinoid .

$B = \mu_o n I$





Q3 (C)

Given

$n = 15/cm = 1500\ m^{-1}$

$A = 2cm^2 = 2 \times (10^{-2})^2 m^2 = 2 \times 10^{-4} m^2$.

$I_1 = 2.0A$.

$I_2 = 4A$.

$\Delta I = 2A$. $N = 1$.

$t = 0.1s$. $\mu_o = 4\pi \times 10^{-7}\ Tm/A$.

$\varepsilon = ?$

formula = $\varepsilon = N \frac{\Delta \Phi}{\Delta t}$

solution

$\varepsilon = N \frac{\Delta \Phi}{\Delta t} = N \frac{\Delta BA}{\Delta t} = N \frac{\Delta (\mu_o n I) A}{\Delta t}$.

$\varepsilon = N \mu_o n A \frac{\Delta I}{\Delta t}$. so

Space for diagram/rough work

Q. No. 3 (Page 6/6)

$\varepsilon = 7.536 \times 10^{-6}$ V

Q. No. 4 (Page 1/6)

Q. No. 4 (Page 2/6)

Q. No. 4 (Page 3/6)

The relevant question should be answered only in the allotted space and inside the outer mark

Q. No. 4 (Page 4/6)

Q. No. 4 (Page 5/6)

Space for diagram/rough work

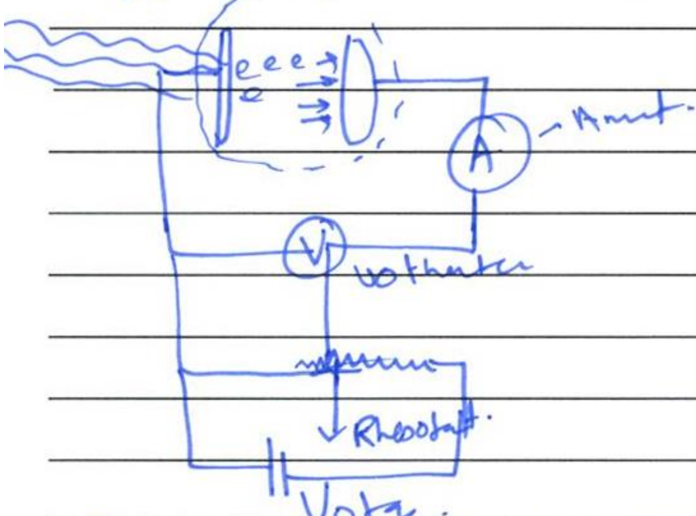
Q. No. 4 (Page 6/6)

Q. No. 5 (Page 1/6) Q 5 (a)

Photoelectric Effect:-

The process of emission of electrons when the photon strikes a surface. The electrons emitted are called photo electrons.

Consider a sys figure in which electrons are produced by striking high frequency photons on cathode which travel towards anode. Photoelectric effect was explained by Einstien.



First Photo electric effect:-

now if the polarity of is changed by reversin the voltage the electrons moving towards anode will slow down because anode will become slightly

Q. No. 5 (Page 2/6) electrons will stop. This reverse voltage is called stopping potential.

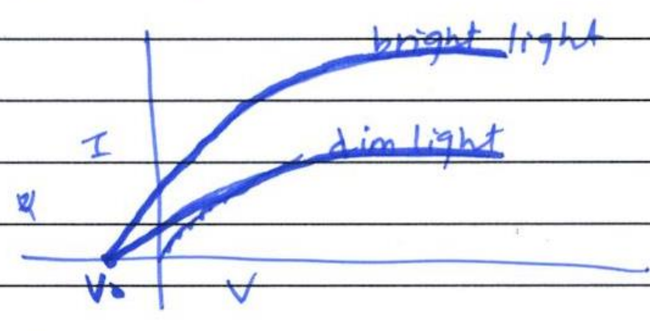
Stopping Potential:-

~~The~~ maximum ~~neg~~ reverse voltage that must be applied inorder to stop the max Kinetic energy electrons is called stopping potential.

K.Emax = eVo.

Effect by increasing intensity

Increasing the intensity of photons, more no of electrons will be ejected as a result photoelectric current will increase.

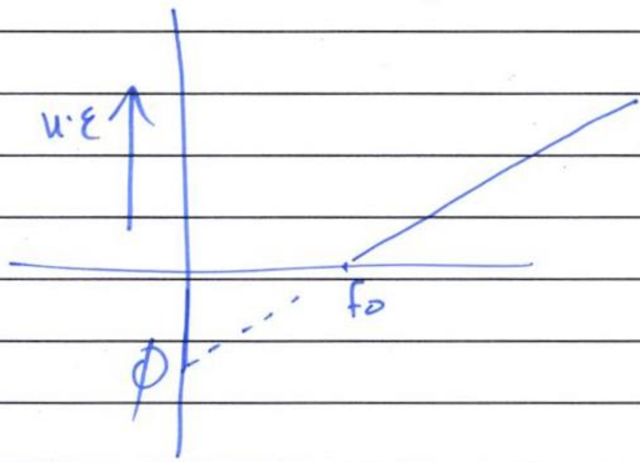


but the stopping potential remains the same. It depends upon frequency and energy not the intensity.

2nd Photoelectric effect:-

~~The~~ Only electrons will be ejected if the photon will have energy equal to the work function and frequency equal to threshold frequency

Q. No. 5 (Page 3/6) to eject electrons.



Einshien's explaination of photo electric effect:-

~~Accordin~~

Einstein used Max plank's quantum theory that energy is emitted in discrete energy level.

$E = hf$.

now

total energy some is converted into work function and kinetic energy.

Work function:-

The minimum amount of energy which must be required to eject electrons is called work function

now

$hf = \phi + K.E$

now $\phi \propto 1/K.E$

if $K.E = 0$

Q. No. 5 (Page 4/6) where f^o is threshold frequency now threshold wavelength or cut off wavelength.

Cutoff wavelength

$$f^o = \frac{\phi}{h}$$

Since $f^o = \frac{c}{\lambda^o}$

$$\frac{c}{\lambda^o} = \frac{\phi}{h}.$$

$$\frac{\lambda^o}{c} = \frac{h}{\phi}$$

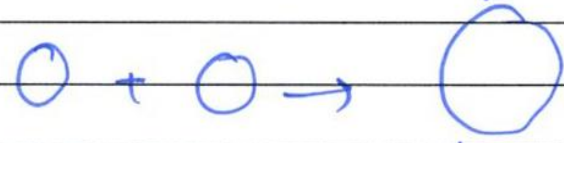
$$\lambda^o = \frac{hc}{\phi}$$

Q5

(b)

Nuclear Fusion:-

"The process in which smaller nuclei combine to form large nuclei with release of large amount of energy is called nuclear fusion"



Q. No. 5 (Page 5/6) Explaination:-

The total mass of the large nucleus will be less than the sum of masses of smaller nuclei because energy is produced from mass by $E=mc^2$ so energy is produced to which is used to bind nuclei together. Nuclear fission reaction is a very high temperature reaction mostly occurs in the stars. A high temperature is required to start fission reaction about 10^8 K which is difficult to be acheived on Earth. Nuclear fusion reaction produces a large amount of heat energy for example

Example:-

.) Proton Proton cycle produces 24.7MeV of energy

.) Carbon Carbon cycle produces 26.7 MeV of energy.

Proton Cycle:-

In proton cycle protons undergo a reactions and liberate ^4_2He. This process produces 24.7MeV energy

Step 1:-

In the first step ^1_1H and ^1_1H combine with the emission of +β and nutrino.

$$^1_1H + ^1_1H \rightarrow ^2_1H + ^0_{+1}\beta + \nu$$

Space for Diagram/rough work

Q. No. 5 (Page 6/6)

^1_1H to produce ^3_2He and γ particle

$$^2_1H + ^1_1H \rightarrow ^3_2He + \gamma$$

Step 3:- In next step ^3_2He and ^3_2He combine to form ^4_2He

$$^3_2He + ^3_2He \rightarrow ^4_2He + ^1_1H + ^1_1H + \gamma$$

now

Step	Reaction	Energy
1	$^1_1H + ^1_1H \rightarrow ^2_1H + ^0_{+1}B$	0.42 Mev (twice)
2	$^2_1H + ^1_1H \rightarrow ^3_2He + \gamma$	5.46 MeV (twice)
3) 4)	$^3_2He + ^3_2He \rightarrow ^4_2He + ^1_1H + ^1_1H$ → $^+B + ^-B \rightarrow B + \gamma$	12.85 MeV 0.51 Mev
		Total: **24.7 MeV** ✓

it shows a large amount of energy is produced in nuclear fussion reaction.

In Carbon Cycle about 26.7 MeV of energy is produced. Although fusion produces a large amount of energy it is difficult to acheive because it requires a very high