Q. No. 2 (i) During a storm (light storm) it is safe to stay inside automobile because as automobile is made of metal so all the charge deposited by light storm resides on surface of car and no charge comes in. Therefore electric field is zero inside car. Hence it is very safe to be inside a vehicle in case of light storm to avoid any hazard of electric charge.

inside car $Q = 0$

so as $E = \frac{kQ}{r}$

$\Rightarrow E = 0.$

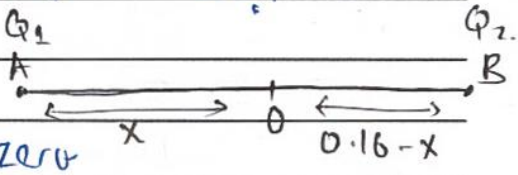
.....

Q. No. 2 (ii) Given:

$Q_1 = 5 \times 10^{-8}\ C$ $\quad k = 9.0 \times 10^9\ Nm^2C^{-2}$

$Q_2 = -3 \times 10^{-8} C$ $\quad r_1 = ?$ $\quad r_2 = ?$

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



Sol:

Suppose at point O, Potential is zero

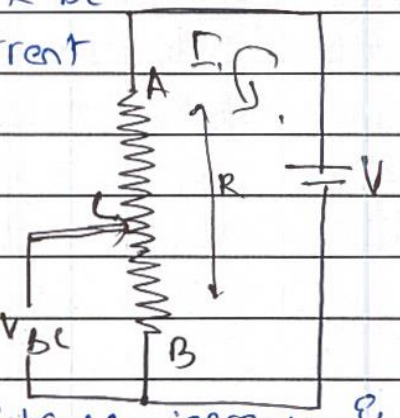
$V_O = V_A + V_B$

$0 = \frac{kQ_1}{r_1} + \frac{kQ_2}{r_2}$ $\quad r_1 = x$ & $r_2 = 16 - x.$

$0 = \frac{(9.0 \times 10^9)(5 \times 10^{-8})}{x} + \frac{(9.0 \times 10^9)(-3 \times 10^{-8})}{0.16 - x}$

$\frac{(9.0 \times 10^9)(+5 \times 10^{-8})}{x} = \frac{(9.0 \times 10^9)(3 \times 10^{-8})}{0.16 - x} \Rightarrow \frac{+3}{x} = \frac{5}{0.16 - x}$

Q. No. 2 (iii) **potential divider:-** Potential divider is a wire wound variable resistor which provide variable potential difference from fixed potential difference. potential divider is shown. let R be resistance of wire AB and I be current through it $I = \frac{V}{R}$



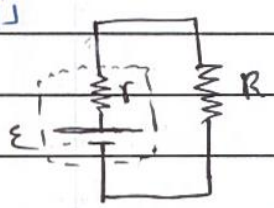
Now wing sliding contact C, the resistance of portion BC can be varied between 0 and 1. If C is moved towards A, the length & resistance increase & potential increases and vice versa. $I = \frac{V_{BC}}{R_{BC}}$

$\frac{V_{BC}}{R_{BC}} = \frac{V}{R}$ $\boxed{V_{BC} = R_{BC}/R \times V}$

.....

Q. No. 2 (iv) **maximum power transfer:-** When the internal resistance of emf source and load resistance are equal, maximum power is transferred in circuit.

consider circuit as shown. r is internal resistance and R is source resistance. Power delivered to load is $P_{out} = I^2R$

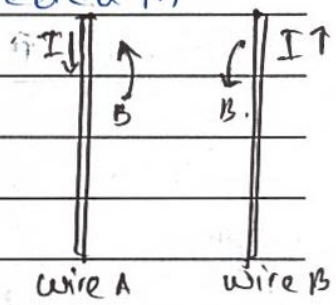


$P_{out} = \frac{\varepsilon^2 R}{(r+R)^2}$ $\because I = \frac{\varepsilon}{r+R}$

$P_{out} = \frac{\varepsilon^2 R}{(r-R)^2 + 4rR}$

now power will be maximum when $r = R$

Q. No. 2 (v) Two wires carrying current in opposite direction repel each other, because the magnetic field in region between the wires is directed in same direction and we know that same magnetic field repel each other, therefore two wires wire repel.



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Q. No. 2 (vi) **Galvanometer:-** Galvanometer is an electrical device used to measure small current. It works on principle that current carrying coil in magnetic field experiences torque.

$I_g = 5\,mA = 5 \times 10^{-3}\,A$

$R_g = 100\,\Omega$

$V = 20V$

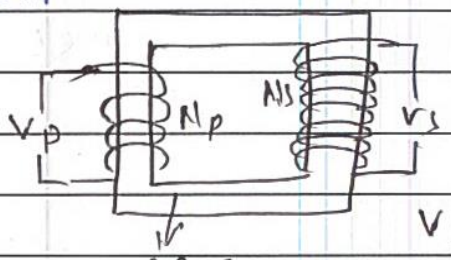
$R_h = ?$

$$R_h = \frac{V}{I_g} - R_g = \frac{20}{5\times10^{-3}} - 100$$

$$R_h = 3900\,\Omega$$

to make voltmeter of 20V range, connect $3900\,\Omega$

Q. No. 2 (vii) Transformer cannot increase or decrease power rather it is used to transfer power from one voltage and current level to other. Therefore step up transformer cannot increase power. It can only increase voltage and decrease current. Step up transforma is shown:-



$V_S > V_P$ & $N_S > N_P$

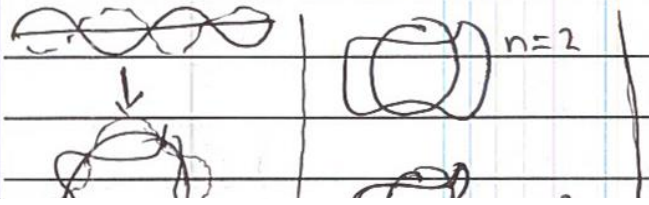
$I_S < I_P$.

.....

Q. No. 2 (viii)

Second postulate:- electron cannot revolve around nucleas in any arbitrary orbit. Only those orbits are possible for which angular momentum of electron is integral multiple of factor $h/2\pi$. $\Rightarrow mvr = nh/2\pi$

It was proved by debroglie in 1923. According to him wavelength is given by $\lambda = h/mv$. Electron can act as a wave like ware act as particle and ware can fit in its orbit as under.

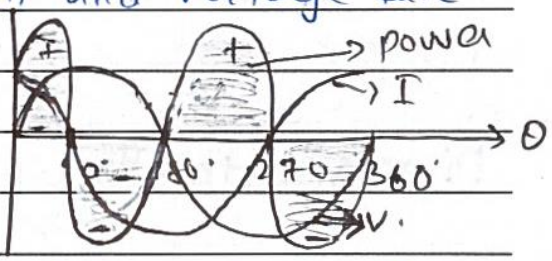


$2\pi r = n\lambda$

$2\pi r = nh/mv$

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

Q. No. 2 (ix) In an ideal capacitor current leads voltage by $\pi/2$ rad or 90°. The wave diagram is given by. as from 0–90° both current and voltage are positive so power is positive and is delivered from source to circuit. during next 90° both are opposite so power delivered is negative and so on process continues. we see that positive powe is equal to negative power therefore total power is zero



$P = V_{rms} I_{rms} \cos\theta$ ∴ $V_R = V_m \sin\omega t$

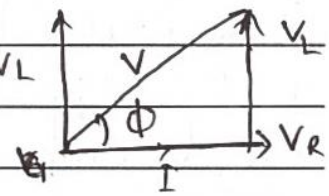
$P = V_m I_m \langle \sin\omega t \rangle \langle \cos\omega t \rangle$ $I = I_m \cos\omega t$

$P = V_m I_m (0)$

$P = 0$ Watt.

.....

Q. No. 2 (x) In R-L series circuit current lags ~~the~~ behind applied voltage. Inductor opposes change of flow of current and serves delay in increase or decrease of current. In inductor V leads I and in Resistor both are in phase. phasor diagram of R-L series circuit is ⇒

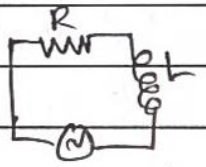


from diagram we see that:-

$V = \sqrt{V_L^2 + V_R^2} = I\sqrt{X_L^2 + R^2}$

$\frac{V}{I} = \sqrt{R^2 + X_L^2} \Rightarrow Z = \sqrt{R^2 + X_L^2}$.

$\Phi = \tan^{-1} V_L/V_R = \tan^{-1}(X_L/R)$



from diagram the equations of current

circuit.

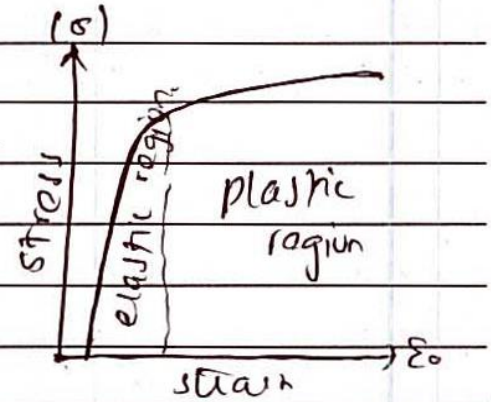
Q. No. 2 (xi) **paramagnetic:-** The orbital and spin axis of electron are aligned in a way to aid each others field and hence substance get magnetized weakly in direction of magnetic field when it is applied so they are weakly attracted by magnet. eg (Aluminium, antimony).

Diamagnetic:- The orbital & spin axis of electron cancel each others effect. In presence of magnetic field they get magnetized in opposite direction and are repelled by magnets ex. Zinc, Copper, bismuth.

Ferromagnetic:- Tiny atoms behave like magnet and substance get magnetized in absence of external field. After applying magnetic field these substances are strongly attracted by magnets. They consist of magnetic domain eg => Iron, Cobalt, Nickel.

.....

Q. No. 2 (xii) The stress-strain curve for ductile material matial is shown. These material fracture at high stress and can be easily worked out. They have ability to absorb more energy and therefore can be drawn out in thin thread like structures. ~~exam~~ In ductile materials the UTS and fracture point are far apart. examples are soft iron, wrought iron, low carbon steel etc.



Q. No. 2 (xiii) Magnetic leritation or Magler train work on principal of superconductors. The train is made to suspend in U-shaped track made of ~~semico~~ superconductors which provide very strong magnetic field and induce magnetic field in train due to current in them. Both fields repel and train remains suspended in path. This allows train to achiere theredile speed of 361 mph by eleminating friction between train and track.

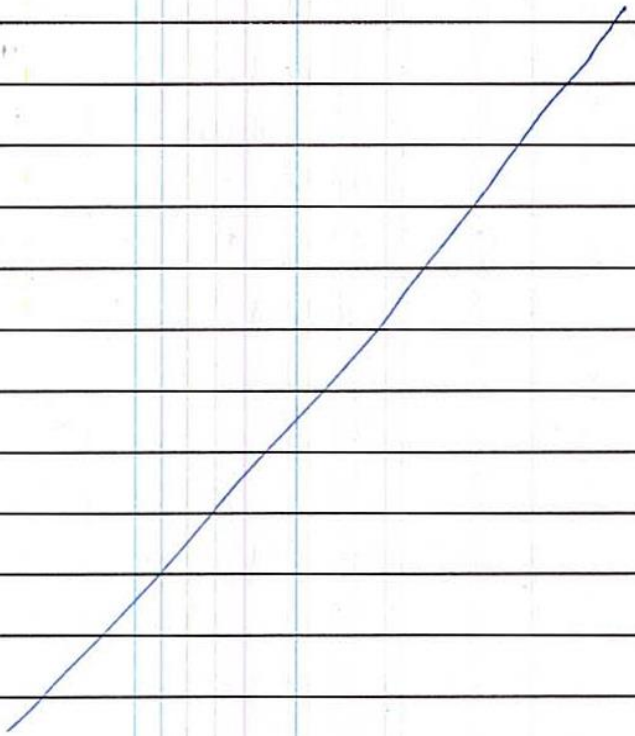
.....

Q. No. 2 (xiv) Transistors are called current amplifying derice because they provide large current and voltage gain to input signals. There is large potential drop accross output collector resistance which increases amplitude. lets have an common emitter transistor. The current gain is given by

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

where β is current gain, I_B is input current & I_C is output current. Suppose value of $\beta = 100$. Now for small base current (foreg 10A) we will have very large output current ($I_C = 1000A$). Thats why

Q. No. 2 (xv)



.....

Q. No. 2 (xvi) in transistor we have

$I_C = \alpha I_E$

$\alpha = I_C / I_E$

α & β are amplification factors

$I_C = \beta I_B$

$\beta = I_C / I_B$

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

$$\beta = \frac{\alpha}{\frac{I_E - I_B}{I_E}} = \frac{\alpha}{1 - \frac{I_B}{I_E}}$$

$\because I_E = I_C + I_B$

Q. No. 2 (xvii)

Given:-

$\Delta t = 10^{-8} s$

required:-

$\Delta E = ?$

formula:-

$\Delta E \cdot \Delta t = h$

Solution:-

$$\Delta E = \frac{6.626 \times 10^{-34} J_s}{10^{-8} s}$$

$$\boxed{\Delta E = 6.626 \times 10^{-26} J}$$

Q. No. 2 (xviii) for paschen series we have

$p = 3$

second line $\Rightarrow n = 5$

wavelength is given by

$$\frac{1}{\lambda_n} = 1.0974 \times 10^7 \left\{ \frac{1}{p^2} - \frac{1}{n^2} \right\}$$

$$\frac{1}{\lambda_5} = 1.0974 \times 10^7 \left\{ \frac{1}{9} - \frac{1}{25} \right\}$$

$$\frac{1}{\lambda_5} = 780373.3333 \ m^{-1}$$

$$\lambda_5 = 1.281643 \times 10^{-6} \ m$$

$$\boxed{\lambda_5 = 1281.4 \ nm}$$

متعلقہ سوال کا جواب صرف مختص کردہ جگہ پر اور بیرونی نشان کے اندر دیا جائے۔

Q. No. 2 (xix)

In order to achiere fusion the two nuclic must be moved closer to each other with a great speed by doing work on them. for this large temp is reaulired, as great as 10 million degree celcius. This tempeature can be very difficult to achiere and mantain which makes fusion difficult to achieve.

Q. No. 2 (xx) equation:-

$$^{234}_{92}Th \longrightarrow {}^{234}_{91}Pa + {}^{0}_{-1}\beta + \bar{V} + Q.$$

required :-

$Q = ?$

solution :-

as Q is rest mass difference ,

L.H.S $Th = 234.0436\,u$

R.H.S $\Rightarrow 234.0423\,u + 0.00055\,u + 0$

$= 234.04335\,u$

$Q = L.H.S - R.H.S = 234.0436 - 234.04335$

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

$1\,u = 931.5\ MeV$

$2.5 \times 10^{-4}\,u = 0.232875\ MeV$.

متعلقہ سوال کا جواب صرف مختص کردہ جگہ پر اور بیرونی نشان کے اندر دیا جائے۔

Q. No. 3 (Page 1/6)

Q. No. 3 (Page 2/6)

متعلقہ سوال کا جواب صرف مختص کردہ جگہ پر اور بیرونی نشان کے اندر دیا جائے۔

Q. No. 3 (Page 3/6)

Q. No. 3 (Page 4/6)

متعلقہ سوال کا جواب صرف مختص کردہ جگہ پر اور بیرونی نشان کے اندر دیا جائے۔

Q. No. 3 (Page 5/6)

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

Space for diagram/rough work

Q. No. 3 (Page 6/6)

Q. No. 4 (Page 1/6)

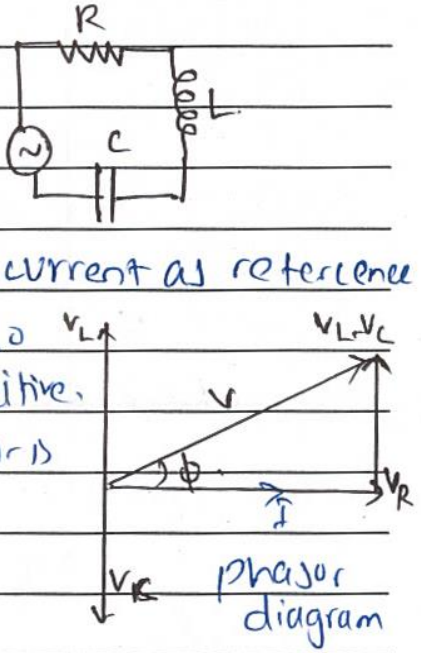
R-L-C series circuit, Impedance, Resonant frequency

Impedance:-

The combined effect of resistances and reactances in AC circuit is known as Impedance. It is opposition offered to flow of current & is represented by Z. $Z = V/I$.

Impedance of R-L-C circuit:-

The resistor, capacitor and Inductor joined in series form RLC series circuit. (diagram is shown):- Voltage drop across R is IR, across L is IX_L & across C = IX_C. All components share common current and therefore phasor diagram is given by taking current as reference vector. as circuit contain X_C and X_L so circuit will be either inductive or capacitive. Suppose $X_L > X_C$, so now resultant vector is $V_L - V_C$. from diagram.



phasor diagram

$$V = \sqrt{V_R^2 + (V_L - V_C)^2}$$

$$V = \sqrt{I^2R^2 + I^2(X_L - X_C)^2}$$

$$V = I\sqrt{R^2 + (X_L - X_C)^2}$$

$$V = I\sqrt{R^2 + X^2} \quad \because X_L - X_C = R.$$

$$Z = \sqrt{R^2 + X^2} \quad \because V/I = Z.$$

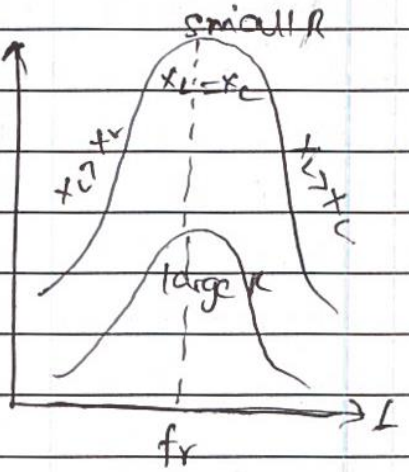
Impedance triangle can be formed which is given as. where

Q. No. 4 (Page 2/6)

if $X_L - X_C$ is positive. circuit is inductive
if $X_L - X_C$ is negative. circuit is resistive.
power factor is $\cos\phi = \frac{R}{Z} = \frac{R}{\sqrt{R^2+X^2}}$

Resonance condition:-

We have studied case when $X_C > X_L$ or $X_L < X_L$ but when $X_L = X_C$ an interesting situation arises. The circuit becomes purely resistive with power factor unity. The frequency at that point is known as resonant frequency and increasing or decreasing that ~~of~~ frequency reduces current. The graph of frequency & current is shown.



~~defect~~ for every combination of X_L & X_C there is only one resonant frequency. given by

$$X_L = X_C$$

$$2\pi f L = \frac{1}{2\pi f C}$$

$$f_r^2 = \frac{1}{4\pi^2 LC}$$

$$f_r = \frac{1}{\sqrt{4\pi^2 LC}}$$

$$\boxed{f_r = \frac{1}{2\pi\sqrt{LC}}}$$

Impedance at resonance = $Z = \sqrt{R^2 + (X_L - X_L)^2}$

$$Z = R.$$

Q. No. 4 (Page 3/6)

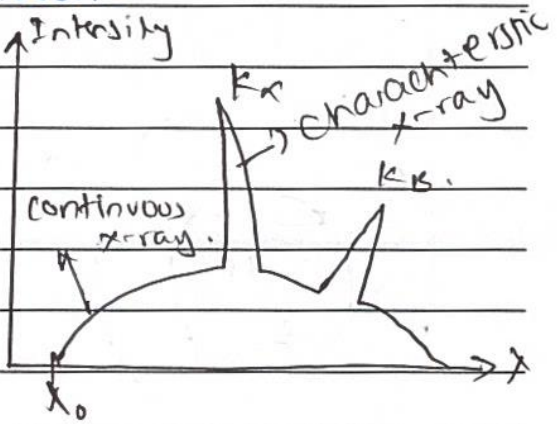
- Current is maximum
- Impedance is minimum
- Circuit is resistive
- power factor is one.

(b)

X-rays:-

X-rays are electromagnetic waves having wavelength in order of angstrom. There wavelength is from 0.1 Å – 100 Å. They are produced by innershell transition of electrons. They are also produced ~~by~~ when accelerated charges are slowed down. X-rays have wide range of application in medical, scientific and industrial fields. x-ray spectrum is shown.

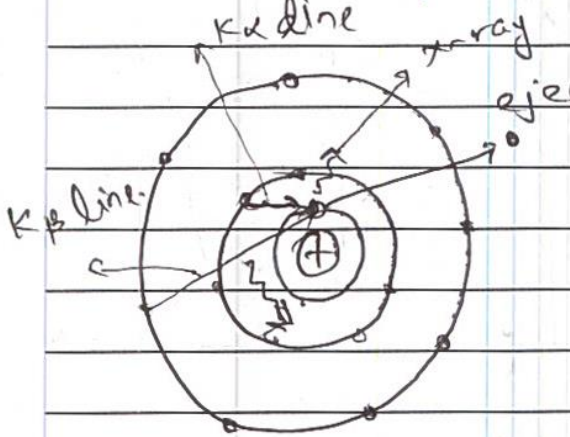
The x-ray spectrum consist of two parts, continous rays with cutoff wavelength λ_0 and characteristic x-rays showing peaks K_α & K_β and so on.

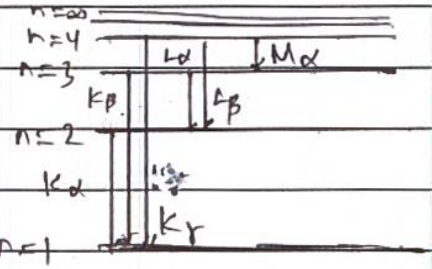


Inner Shell transition X-rays:-

In heavy elements like molebdenum electrons are arranged in different orbitals or shells such as K, L, M, N. In these elements the high energetic electrons can knock out electron from inner shell of ~~x-ray~~ target atom, thus creating

Q. No. 4 (Page 4/6) In this process x-ray photons are emitted having energy equal to engy difference of two levels. suppose an electron from K shell is ejected. Now electron from L, M, N... shells will make transition to fill that vacancy resulting in production of K_α, K_β, K_γ... lines which are shown by peaks in spectrum. L_α, L_β... lines can also be achieved by transition of electron from $n=4 \rightarrow n=2$ & $n=4 \rightarrow n=3$ respectively. In same way higher lines can be ~~cetried~~ achieved. Energy of K_α lines are greatest. These are called characteristic rays because they are characteristic of target metal and seperation of energy level in it.



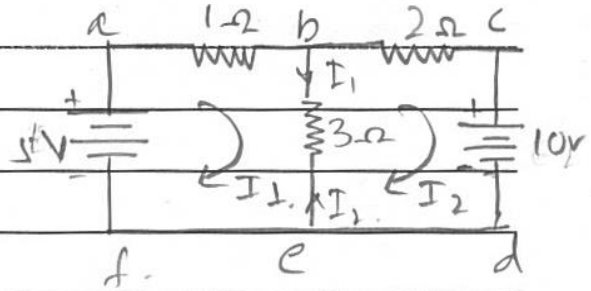


lines of x-rays.

Given:-

$R_1 = 1\Omega$ $E_1 = 5V$

Q. No. 4 (Page 5/6)



applying KVL on loop abefa

$$-I_1R_1 - R_3(I_1 - I_2) + E_1 = 0$$

$$-I_1 - 3(I_1 - I_2) + 5 = 0$$

$$-I_1 - 3I_1 + 3I_2 + 5 = 0$$

$$-4I_1 + 3I_2 = -5$$

$$\boxed{4I_1 - 3I_2 = 5} \quad -(1).$$

applying KVL on loop bcdeb.

$$-I_2R_2 - E_2 - R_3(I_2 - I_1) = 0$$

$$-2I_2 - 10 - 3(I_2 - I_1) = 0$$

$$-2I_2 - 3I_2 + 3I_1 = 10$$

$$-5I_2 + 3I_1 = 10$$

$$\boxed{5I_2 - 3I_1 = -10} \quad -(2).$$

multiply (1) by (3) and (2) by 4 and add

$$(1) \Rightarrow 12I_1 - 9I_2 = 15$$

$$(2) \Rightarrow 20I_2 - 12I_1 = -40$$

$$11I_2 = -25$$

$$\boxed{I_2 = -2.27\,A}$$

$$(1) \Rightarrow 4I_1 - 3(-2.27) = 5$$

$$4I_1 = -1.81$$

$$\boxed{I_1 = -0.4525\,A}$$

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

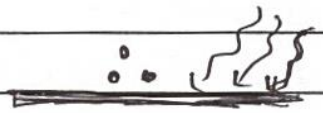
Space for diagram/rough work

Q. No. 4 (Page 6/6)

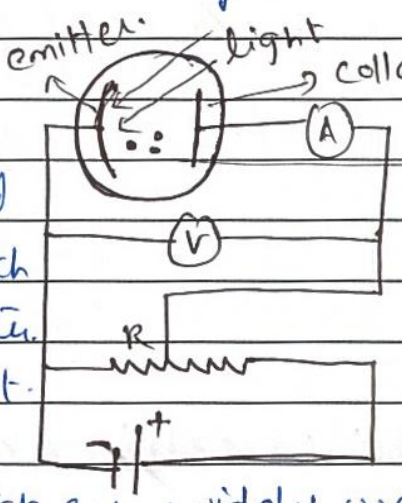
Q. No. 5 (Page 1/6)

~of(a)o~

Photoelectric Effect:- When light falls on metal surface electrons are emitted. These electrons are called photoelectrons and phenomenon is known as photoelectric effect.



The phenomenon of photoelectric effect was first discovered by Heinrich Hertz in 1887 and Einstein explained it in 1905. The experimental arrangement is shown.



When light of certain specific frequency falls on cathode metal electrons are emitted and collected by collector which cause deflection in ammeter & current flows in circuit. Photoelectric effect is used in photocell which are widely used in bugular alarms, automated doors etc.

We will make 2-observation using above arrangement:-

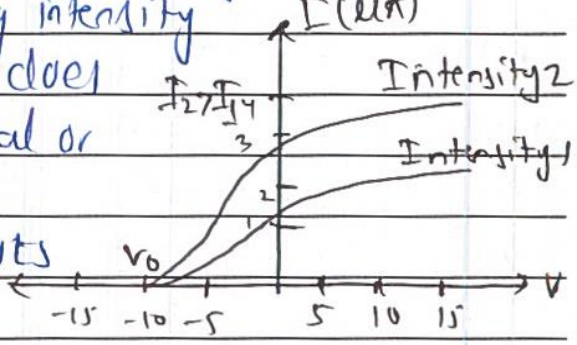
First photoelectric experiment:-

We measure stopping potential by this method. The negative & positive terminals of battery are interchanged so that collector becomes negative with respect to emitter & thus starts to repel electrons arriving. At certain specific value

Q. No. 5 (Page 2/6) stopping potential V_0. At that potential the electron with maximum kinetic energy is just stopped to pass collector. max kinetic energy can be calculated as.

$K.E_{max} = eV_0$ $\quad \because e = 1.602 \times 10^{-19} C$

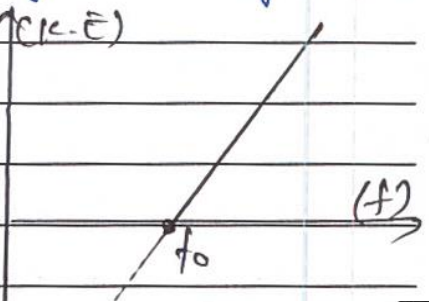
kinetic energy depends on V_0 and frequency of incident light and is independent of intensity. Increasing intensity only increases number of photoelectrons. The graph of I & V is shown and two intensity levels. It is clear that increasing intensity only increases current but does not effect stopping potential or kinetic energy.



Classical physics suggests that if we use intense light it must provide more energy to electron because light is a wave. This is what that does not happen.

Second photoelectric experiment:-

Now we use arrangement of figure ① and measure the effect of kinetic energy by increasing or decreasing frequency of ~~emitted~~ source light. The graph of K.E vs frequency is shown.



we see that photoelectric effect does not occur if frequency of incident light is less than certain threshold frequency to

Q. No. 5 (Page 3/6) λ_0. by wave equation

$$f_0 = c\lambda_0$$

$$\lambda_0 = c/f_0.$$

Classical physics suggest that whatever be the frequency of incident light the photoelectric effect will occur if we use bright light. This does not happen.

Another trouble of classical physics is that it suggest time delay for emission of electrons but it is not observed. The electrons are emitted as soon as light falls on metal.

Einstein explanation:.

Einstein explained this phenomena using plank's theory that light is quantized & consists of packets of energy called photons

$$E = hf.$$

He said that the kinetic energy of electron is given by

$$K.E_{max} = hf - \phi \quad \text{--(1)}$$

where ϕ is work function. It is energy with which electrons are bound to metal surface & this amount of energy is required for photoelectric effect to occur. This equations shows independence of intensity & kinetic energy.

It also gives concept of threshold frequency. The light with threshold frequency will only be able to eject electron with zero kinetic

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$O = hf_0 - \phi$

$\phi = hf_0$

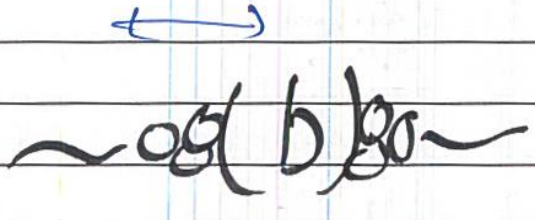
$\phi = \frac{hc}{\lambda_0}$

so equation (1) takes form as

$K.E_{max} = hf - hf_0$

$\boxed{K.E_{max} = h(f - f_0)}$

This is einstein equation of photoelectric effect.



Nuclear fusion:- When two light nuclie are diffused together to form heavy nucleus. This phenomenon is known as fusion.

In order to fuse to nuclie energy must be provided, work must be done to overcome repulsive force between nuclie. The two nuclie must be moved with high velocity towards each other & this can be done only in presence of temperature as high as 10 million degree celcius. which is quite difficult to achieve - Hence this makes fission difficult to achieve.

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The mass of resultant nuclie is less than mass of nuclie that formed it. This loss of mass appears as energy of reaction. since $E=mc^2$. mass can be converted to energy & viceversa.

Fusion is favourable in atmosphere of stars & sun. 2 cycles of fusion are proton cycle and carbon cycle. Here we will only discuss proton cycle.

proton-proton cycle:- This cycle is favoured by stars having temperature less than sun. Protons are converted to helium nuclie in this process. firstly 2 protons combine to form deutium which combines with another proton form ^3_2He. Both two such molecules combine to form ^4_2He & released proton. This cycle is continued in this way. The steps involved are-

Step1:	$^1_1H + {}^1_1H \rightarrow {}^2_1H + {}^0_{+1}\beta + \nu$	(twice)	0.42 Mev
Step2:	$^1_1H + {}^2_1H \rightarrow {}^3_2He + \gamma$	(twice)	5.49 Mev
Step3:	$^3_2He + {}^3_2He \rightarrow {}^4_2He + {}^1_1H + {}^1_1H + \gamma$		12.85 Mev
Step4:	$^0_{-1}e + {}^0_{+1}e \rightarrow 2\gamma$	(twice)	1.02 Mev
Net:-	$4\,{}^1_1H \rightarrow {}^4_2He + 2\,{}^0_{+1}\beta + 2\nu + 2\gamma$		26.71 Mev

The energy released in this process is 26.71 Mev. The diagram is shown on next page.

Space for Diagram/rough work

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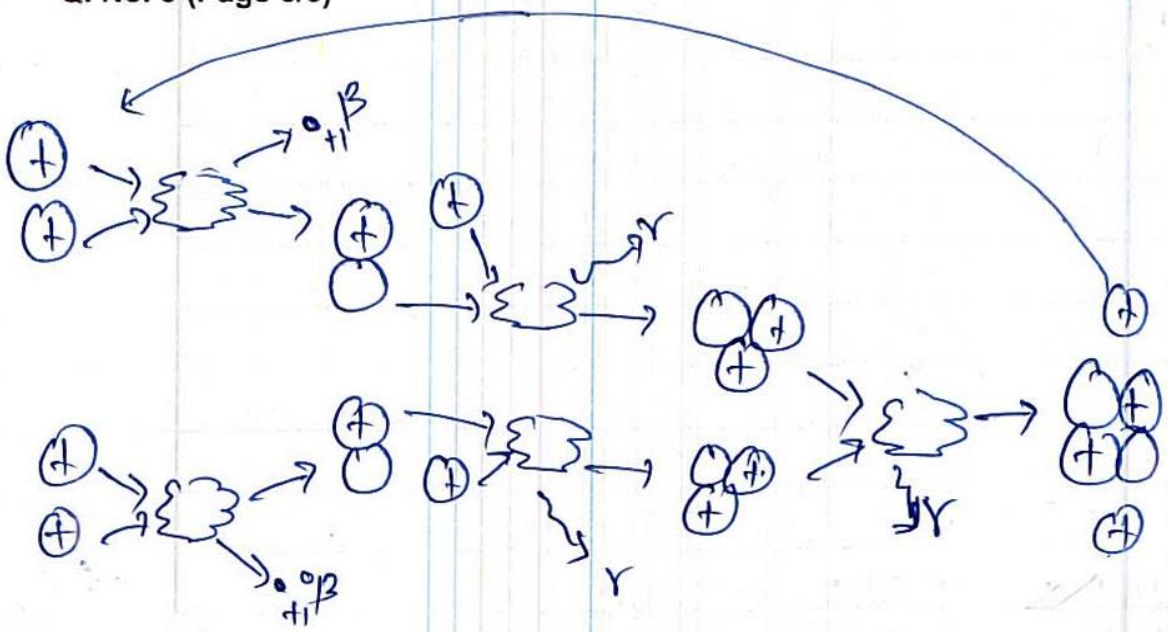

proton cycle.

THE END!