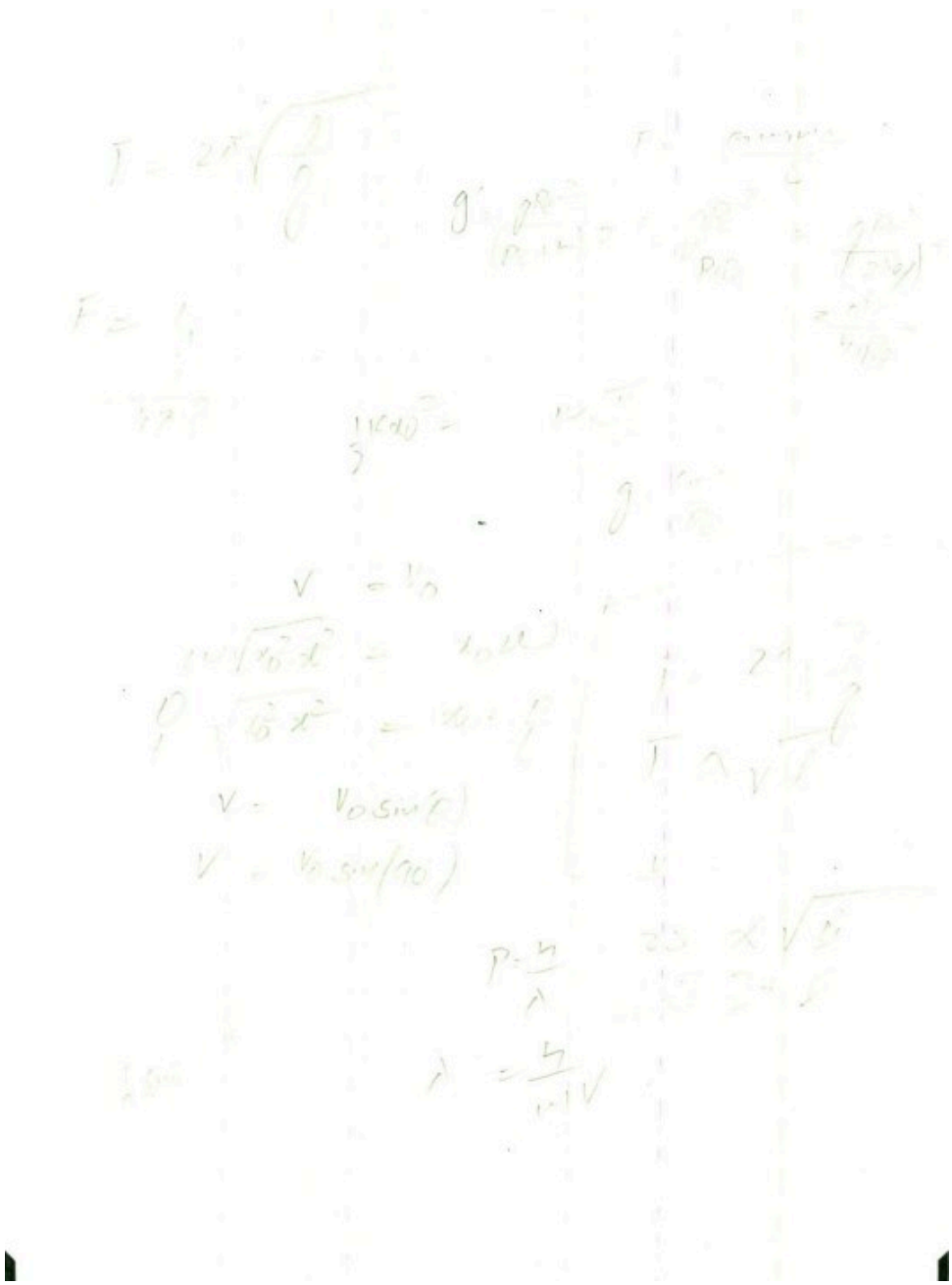






(Section B)

Q. No. 2 Part (I) **Given:**

$T = 0.4s$ $x = 4cm$

To find: $a = ?$

Solu: $a = -x\omega^2$

to find $\omega = \frac{2\pi}{T} = \frac{2\pi}{0.4} = 15.7 \text{ rads}^{-1}$

$a = -x\omega^2$

$= -(4\times10^{-2})(15.7)^2$

$= -(9.8)$

$\vec{a} = -9.8 \text{ ms}^{-2}$

So the magnitude of accelexation is 9.8 ms^{-2}

Hexe -ve sign shows its dixection towards mean position.

.....

Q. No. 2 Part (II) **Constructive Interfexance:**

The interfexance of two waves in which the cxest lie ovex cxest and txough lie ovex txough of one wave to the second. Thexe is ovexlapping of cxest to cxest and txough to txough of both waves. Ovexall amplitude incxeases.

Path difference: It is integxal multiple of λ

Path difference = $n\lambda$ i.e $n = 1, 2, 3 \ldots$

Destxuctive Interfexance

The interfexance of two waves in which the cxest may lie ovex the txough ox vice vexsa. Thexe is ovexlapping of cxest to txough. Ovexall amplitude decxeases of the xesultant wave

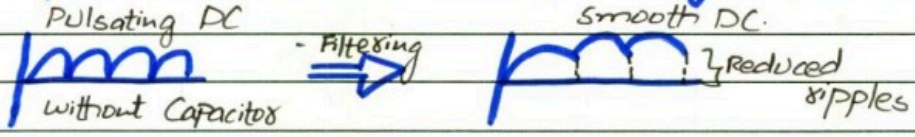
Pathdiffexence: It is odd multiple of half of wavelength

Path diffexence = $(n + 1/2)\lambda$

(Section B)

Q. No. 2 Part (iii) **Use of Capacitor:**

A Capacitor is used in A bridge rectifier to reduce the ripples in the output voltage. It smooths the output. It is used to convert pulsating DC into smooth DC. A capacitor can be fully charged when the voltage is maximum. After voltage drops, it slowly supplies the charge to resistor and smooths the output. Capacitance of capacitor also plays a vital role in charging and smoothing. A high capacitance value causes better smoothing but increases charging current Capacitor are used in **filtering circuit**



Q. No. 2 Part (iv) **Given:** $h = 1500\ km$

To find: $g_h = ?$

Sol:

$$g_h = \frac{gR_e^2}{(R_e+h)^2}$$

$$g_h = \frac{(9.8)(6400\times10^3)^2}{(6400\times10^3 + 1500\times10^3)^2}$$

$$= \frac{(9.8)(6400\times10^3)^2}{6.241\times10^{13}}$$

$$g_h = 6.43\ ms^{-1}$$

The g at 1500 km would be $6.43\ ms^{-2}$

(Section B)

Q. No. 2 Part (v) **Temp & Kinetic Energy**

as from ideal gas equation: $PV = nRT$

$PV = NKT$ — (a) $\frac{R}{N_A} = n$

$PV = N(\frac{R}{N_A})T$

as from pressure of ideal gas $PV = NKT$

$P = \frac{mN}{3V} \times \langle v^2 \rangle \times \frac{2}{2}$

$= \frac{2N}{3V} \times \frac{1}{2} mv^2$

$PV = \frac{2}{3}N \times \frac{1}{2} mv^2$ — (b)

from equating (a) and (b)

$NKT = \frac{2}{3}N \times \frac{1}{2} mv^2$

$T = \frac{2}{3K} \times K.\bar{E}$ $K.E = \frac{1}{2} mv^2$

as $\frac{2}{3K}$ = constant

$T \propto K.\bar{E}$

Conc: $K.\bar{E}$ is directly proportional to temperature

.....

Q. No. 2 Part (vi)

Use of X rays:-

Hard-tissues:- X rays are high energy and shorter wavelength rays that can transmitt through the human body and give picture of especially bones. The rays passed through the body and detected at the back with the help of detector. The Ca^{+2} ion plays an important role in X-rays of bone.

Soft tissues:- In case of soft tissue X-rays cannot be used directly. There is usage of CONTRAST. contrast is the range of brightness from high to low. Via contrast X-rays are used in imaging of soft tissue.

(Section B)

Q. No. 2 Part (vii) **Pair Production:**

The phenomenon in which a high energy photon comes near a nucleus, interacts with it and gives a pair of electron-positron.

Energy:

Photon Energy = hc/λ

$$\frac{hc}{\lambda} = m_{e^-}c^2 + m_{e^+}c^2 + KE_{e^-} + K.E_{e^+}$$

for minimum energy (as $K.E = 0$)

$$hf = m_{e^-}c^2 + m_{e^+}c^2$$
$$= 2(mc^2)$$
$$= 2(9.31\times10^{-31})(3\times10^{8}) \quad m_{e^-} = m_{e^+} = 9.31\times10^{-31}\,kg$$
$$hf = 1.02\,MeV$$

So the minimum energy of photon = **1.02 MeV**

Q. No. 2 Part (viii) **Piezo Electric Effect:**

The phenomenon in which specific substances generates electrical charge when face mechanical stress

Example: Lithium Niobate, Quartz etc.

Applications: "detection of high voltage and electronic frequency gen"

Ultrasound detection:- When ultrasound after striking the organ are received by piezoelectric transducer, the generates electrical signals after being subjected to such a high mechanical stress (sound waves)

Speed of fluids:- Piezoelectric Effect is used to detect speed of fluids. Variation of speed of molecules is found by sending soundwaves towards them which faces dopplers shift. The shift is then expressed as electrical signals by using piezoelectric effect.

(Section B)

Q. No. 2 Part (ix) **Control Rods:** They are also called as Safety rods. They are made of boron or cadmium They are used to absorb excess of neutrons and allow one neutron from Each fission event to strike the other nuclei. In this way they play an important role in controlling extent of reaction. If they are not present all the Uranium would be used once **Moderator:** They are used for slowing down of the neutrons. As the neutrons formed from fission event are fast moving. But for fission event we use slow moving neutrons. For this purpose moderator are used that are made of water or graphite and reduces neutron energy upto 0.025eV

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Q. No. 2 Part (x)

Idea:- The idea of Expanding Universe is predicted by red-shift.

Reason:- Expanding Universe states that universe is constantly expanding since its origin. Red-shift is the receding of celestial object. It means that there is some vacany being generated continuously, thats why an object moves away from Earth. The idea of expanding universe is same as Air being blown into a ballon. As the baloon expands continuously and air molecules are separated from Each other. The same reason is here for the redshift.

(Section B)

Q. No. 2 Part (xi) **Mass defect:** The difference in the masses of actual masses of nucleus and the sum of masses of its constituents.

formula => $\Delta m = (A-Z)m_n + Zm_p) - m_{nucleus}$

mass defect of $He_2^4 = (2\times(1.008665) + 2(1.007276)) - 4.002603$

$= 4.031882 - 4.002603$

$\Delta m = 0.029279\ u$

Binding Energy: The amount of energy is required to brake an isolated nuclei into its constituent is called binding energy.

formula => $E = \Delta mc^2$

$= (0.029279 \times 1.66\times10^{-27})(3\times10^8)^2$

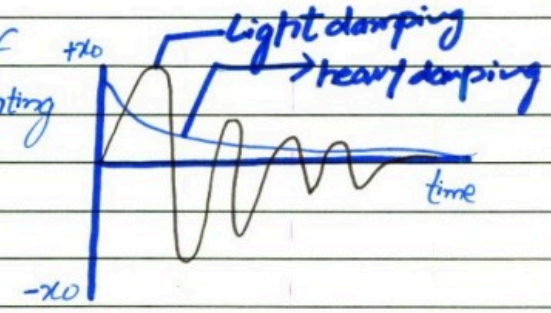
$E = 27\ MeV$

Q. No. 2 Part (xii) **Light Damping:** The damping is said to be light when the amplitude of vibrating body gradually decreases with time.

Example: a child swinging of swing slowly comes to rest.

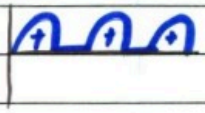
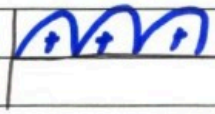
Heavy Damping: The damping in which the vibrating body comes to rest nearly even completing a single vibration.

Example:- Damping of simple pendulum vibrating in thick liquid.



(Section B)

Q. No. 2 Part (xiii)

Half-wave	Full-wave
Graph	
	
Def	
The input voltage reduced to pulsating DC with gaps	The input voltage reduced to pulsating DC without gaps.
Fsequency	
Fsequency of Half wave becomes same as of input	Fsequency of full waves become double as compare to input
Diode	
Uses 1 diode	Uses 2 or 4 diode

Q. No. 2 Part (xiv)

Sol: Hexe 2 capacitors axe joined in series

for wixe-1 : $C_{eq} = \frac{C}{n}$

$C_{eq_1} = C/2 \Rightarrow C_{eq_1} = \frac{C}{2}$

Same for wixe-2 $C_{eq_2} = \frac{C}{n}$

$C_{eq_2} = \frac{C}{2}$

For Combined Capacitance (Paxallel) (**Conc:** The C_{eq} is same as individual capacitare)

$C_{eq} = C_{eq_1} + C_{eq_2}$

$= C/2 + C/2$

$\boxed{C_{eq} = C}$

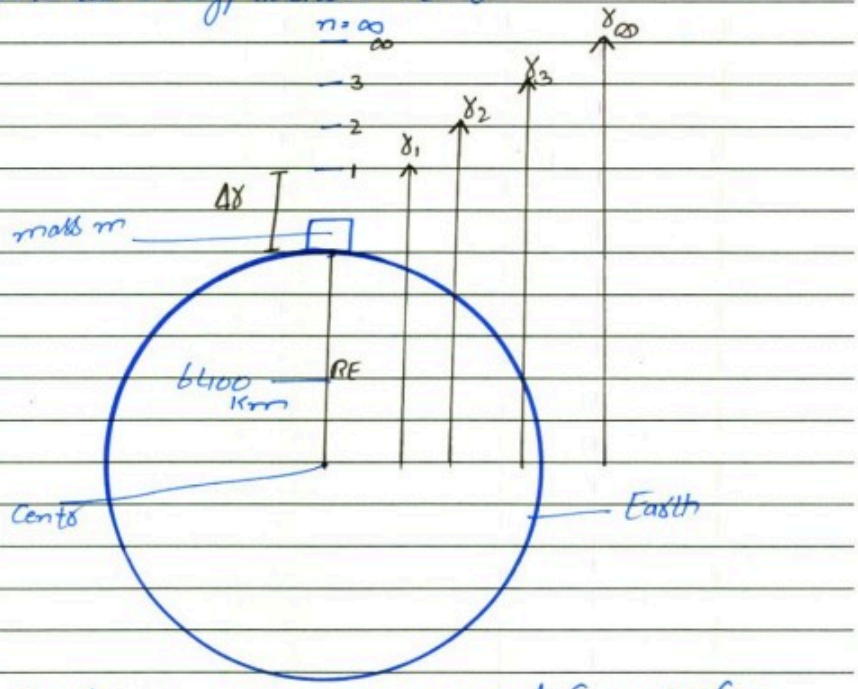
(Section C)

Q. No. 3 (Page 1)

Gravitational Potential Energy:

Def: The amount of energy required to move a mass from the surface of Earth to at infinity where the value of g is negligible.

Explanation:- $\Delta P.E = mg\Delta h$ holds for the points where g is constant. Also we need to establish a reference point often the Earth surface to find potential energy relation with r.



Consider a mass m is moved from surface of Earth to point-1

(Section C)

Q. No. 3 (Page 2) From work-Energy principle

$\Delta P.E = W_{net}$

$W_{net} = W_1 + W_2 + W_3 \ldots W_n$

$W_1 = F_{av} \Delta x$

as the g varies so the F_g, so we use F_{av}

$W_1 = F_{av} \Delta x \cos\theta$

$W_1 = F_{av} \Delta x \cos(180)$

$W_1 = -F_{av} \Delta x$

Here -ve sign shows opposite direction of F_g & Δx

as $F_{av} = \frac{G m_1 m_e}{r_{av}^2}$

$W_1 = -\frac{G m_1 m_e}{r_{av}^2} (\Delta x)$ — (a)

to find r_{av}

$r_{av} = r_1 + R_e/2$

$= 2R_e + \Delta x/2$

$(r_{av})^2 = (R_e + \Delta x/2)^2$

$r_{av}^2 = R_e^2 + \Delta x^2/4 + R_e \Delta x$

as Δx is very small its square would be more small

$r_{av}^2 = R_e^2 + R_e \Delta x$

$r_{av}^2 = R_e^2 + R_e(r_1 - R_e)$

$r_{av}^2 = R_e^2 + R_e r_1 - R_e^2$

so $r_{av}^2 = R_e r_1$ — put in eq (a)

$W_1 = -G m_1 m_e \left(\frac{\Delta x}{R_e r_1}\right)$

$= -G m_1 m_e \left(\frac{r_1 - R_e}{R_e r_1}\right)$

$= -G m_1 m_e \left(\frac{1}{R_e} - \frac{1}{r_1}\right)$

(Section C)

Q. No. 3 (Page 3) Same for $W_2 = -GmMe\left(\frac{1}{\gamma_1} - \frac{1}{\gamma_2}\right)$

for $W_3 = -GmMe\left(\frac{1}{\gamma_2} - \frac{1}{\gamma_3}\right)$

for $W_n = -GmMe\left(\frac{1}{\gamma_{n-1}} - \frac{1}{\gamma_n}\right)$

By combining all

$W_{net} = W_1 + W_2 + W_3 \cdots W_n$

$= -GmMe\left(\frac{1}{Re} - \frac{1}{\gamma_1} + \frac{1}{\gamma_1} - \frac{1}{\gamma_2} + \cdots - \frac{1}{\gamma_n}\right)$

$W_{net} = -GmMe\left(\frac{1}{Re} - \frac{1}{\gamma_n}\right)$

So $W_{net} = -GmMe\left(\frac{1}{Re} - \frac{1}{\gamma_n}\right)$

Generalizing the eq and excluding the choice of reference and taking $n = \infty$

$W_{net} = -GmMe\left(\frac{1}{\gamma} - \frac{1}{\infty}\right)$

$= -GmMe\left(\frac{1}{\gamma} - 0\right)$

$W_{net} = -GmMe/\gamma = P.E$

So Gravitational P.E

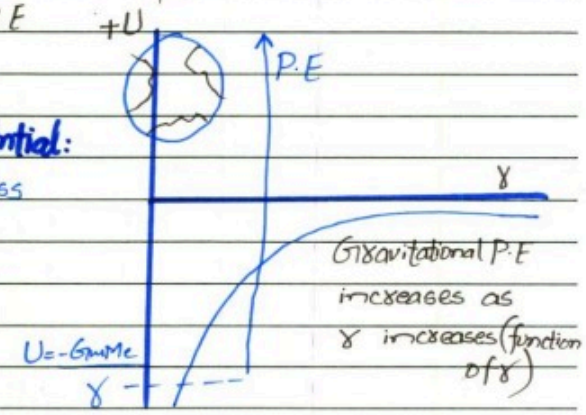
$U = -\frac{GmMe}{\gamma}$

Gravitational Potential:

P.E per unit mass

$V = \frac{U}{m}$

$V = -\frac{GMe}{\gamma}$



(Section C)

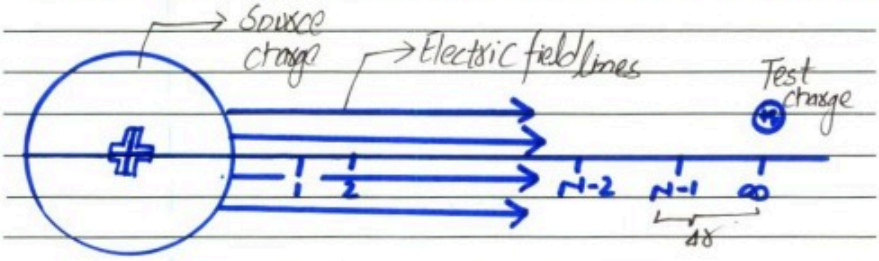
Q. No. 4 (Page 1)

Electxic Potential :-

Def: Electxic potential energy pex unit charge is called electxic potential.
It is used to express the effect of field at a certain point.

Due to Point Charge :-

The basic xelation $E = -\Delta V . x$ is used where the electxostatic fosce is constant. Howevex in many cases it is not constant. Fox thai we dexive anothex xelation.



Consides a test chaxge +q is psesent at $n = \infty$.
It is bxought to cextain point inside the field by doing woxk-done.

$$W_{N-N-1} = F . \Delta x$$

$$W_{N-NH} = F \Delta x \cos(180^\circ)$$

$$W_{N-N-1} = -F \Delta x \quad — (a)$$

Hexe -ve sign shows opposite disection of F and Δx

as $F = qE$ — put in eq

$$W_{N-N1} = -qE \Delta x \quad — (b)$$

as $E = \frac{1}{4\pi\varepsilon_0} \times \frac{Q}{x^2}$ — put in eq (b)

(Section C)

Q. No. 4 (Page 2)

Eq (b) becomes

$$W_{N-N-1} = \frac{-Qq}{4\pi\varepsilon_0}\left(\frac{\Delta r}{r^2}\right)$$

as r_N and r_{N-1} are very close to each other so

$r^2 = r_n r_{n-1}$ → Replace in eq (b)

$$W_{N-N-1} = \frac{-Qq}{4\pi\varepsilon_0}\left(\frac{\Delta r}{r_n r_{n-1}}\right)$$

$$= \frac{-Qq}{4\pi\varepsilon_0}\left(\frac{-r_{n-1} + r_n}{r_n r_{n-1}}\right)$$

$$= \frac{-Qq}{4\pi\varepsilon_0}\left(\frac{r_n - r_{n-1}}{r_n - r_{n-1}}\right)$$

$$= \frac{-Qq}{4\pi\varepsilon_0}\left(\frac{r_n}{r_n r_{n-1}} - \frac{r_{n-1}}{r_n r_{n-1}}\right)$$

$$W_{N-N+1} = \frac{-Qq}{4\pi\varepsilon_0}\left(\frac{1}{r_{n-1}} - \frac{1}{r_n}\right)$$

Same as for other cases:

$$W_{N-1-N-2} = \frac{-Qq}{4\pi\varepsilon_0}\left(\frac{1}{r_{n-2}} - \frac{1}{r_{n-1}}\right)$$

$$W_{2-1} = \frac{-Qq}{4\pi\varepsilon_0}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

Combining all eq we have

$$W_{net} = W_{N-N+1} + W_{N-1-N-2} \text{ ---- } W_{2-1}$$

$$= \frac{-Qq}{4\pi\varepsilon_0}\left(\frac{1}{r_1} - \frac{1}{r_2} \text{ ----- } \frac{1}{r_{n-1}} - \frac{1}{r_n}\right)$$

$$W_{net} = \frac{-Qq}{4\pi\varepsilon_0}\left(\frac{1}{r_1} - \frac{1}{r_n}\right)$$

(Section C)

Q. No. 4 (Page 3)

By work energy principle

$$W_{net} = P.E$$

$$E.P.E = \frac{-Qq}{4\pi\varepsilon_0}\left(\frac{1}{r_1} - \frac{1}{r_m}\right)$$

If we bring the charge from infinity.

$$EPE = \frac{-Qq}{4\pi\varepsilon_0}\left(\frac{1}{r_1} - \frac{1}{\infty}\right)$$

$$= \frac{-Qq}{4\pi\varepsilon_0}\left(\frac{1}{r_1}\right)$$

$$EPE = \frac{-Qq}{4\pi\varepsilon_0}\left(\frac{1}{r}\right)$$

Hence:- The amount of work-done in bringing a charge from infinity to that point inside the electric field.

as $V = \frac{EPE}{q}$

$$= \frac{-Qq}{4\pi\varepsilon_0} \times \frac{1}{q} \times \frac{1}{r}$$

$$V = \frac{-Q}{4\pi\varepsilon_0 \cdot r}$$

(Section C)

Q. No. 5 (Page 1)

Photo Electric Effect:

It was performed by Einstein in 1905 and later got the noble prize.

It is define as:

"Emission of Electrons from a metal surface when a light of sufficiently high frequency is subjected to it."

The electrons coming out are called photo electrons.

Threshold Frequency:

The minimum frequency of the light below which no emission of electron occurs. It is the minimum frequency that has the enough energy to remove electrons.

Frequency below threshold:-

As energy of photon depends on frequency. If the frequency would less than f_0, than it has not enough energy to knock out the electrons of the metal surface. That minimum energy required is work-done that is work-function. ϕ

as $E = \phi + K.E$

$E = hf_0 + K.E$

when $f_{photon} > f_0$ photoelectron emit

$f_{photon} < f_0$ no emission because $E < \phi$

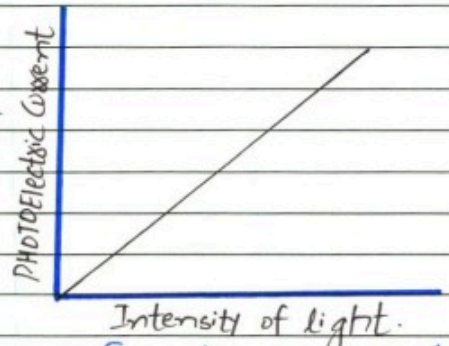
(Section C)

Q. No. 5 (Page 2)

Effect of Intensity of Light:

Increasing the intensity of light effects the photo electric current.

When we increase the intensity of light we came to notice the amount of current also increased. This elaborates a direct relation b/w intensity of light and I. This is because more brighter light will cause more electrons to emit.

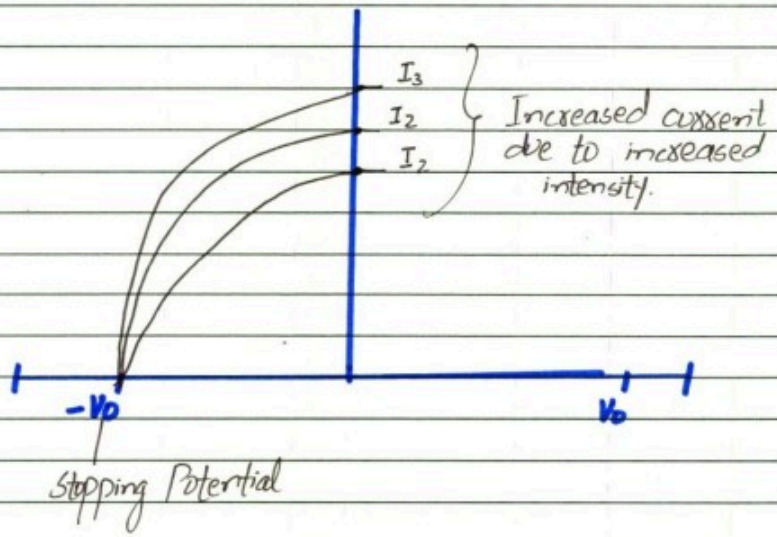


This graph formed is straight line graph.

Also the classical physics suggests that increasing intensity will cause more energy to be transferred to the electron. This is because greater the intensity more amplitude and hence K.E$_{max}$ of electron is increased. But experiment proved it wrong. The stopping potential remained same as intensity increases however photoelectric current increases.

(Section C)

Q. No. 5 (Page 3)



(Section C)

Q. No. 6 (Page 1)

Enrichment:-

The natural found Uranium is not fissile in nature. especially U-238 (99.3%) Also the fissile Uranium U-235 is much less in concentration. 0.7%.

Enrichment means:

The conversion of non-fissile U-238 into fissile U-235 is called enrichment.

The fissile U-235 is 3-5%. U-238 is non-fissile because it absorbs a neutron and convert int P-239.

Reason:-

U-235 is enricted 3-5% because nuclear reactors do not operate at 0.7%.

Nuclear reactors are devices that sustain and control nuclear fission chain reaction.

If the Uranium is present at low conc then nuclear reactors wont operate.

Methods:-

- Gas-diffusion
- Gas-centrifugation
- laser enrichment.

(Section C)

Q. No. 6 (Page 2)

b):

Given:

$t = 5\,min \quad N_0 = 700 \quad \Delta N = 100$

To find:

$\lambda = ? \quad , A = ?$

Sol:

$$A = \frac{\Delta N}{\Delta t}$$

$$= \frac{100}{5 \times 60}$$

$$\boxed{A = 0.333\ Bq}$$

as

$$A = -\lambda N$$

$$\frac{A}{N} = -\lambda$$

$$\lambda = \frac{A}{N}$$

$$= \frac{0.333}{700}$$

$$\boxed{\lambda = 4.76 \times 10^{-4}\ s^{-1}}$$

(Section C)

Q. No. 6 (Page 3)