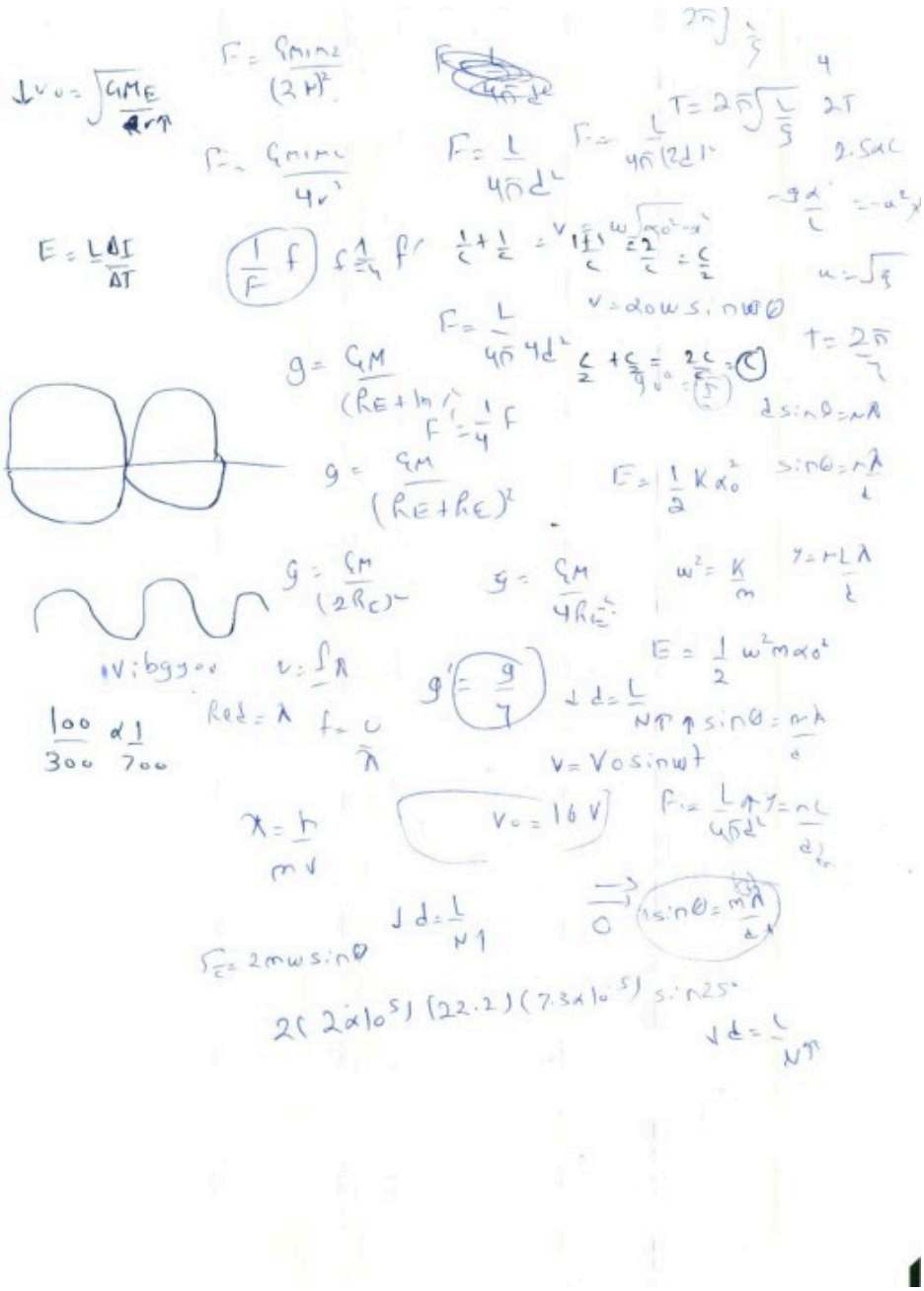






(Section B)

Q. No. 2 Part (I) Effect on orbital velocity:-

When a satellite is put into a higher orbit (Greater orbital radius) value of orbital velocity decreases as $v_o = \sqrt{\frac{GM_E}{r}}$, so ~~when~~ $v_o \propto \sqrt{\frac{1}{r_{v_o}}}$ so when ~~it~~ radius of circular orbit increases orbital velocity decreases.

Mathematically:-

lets consider that a satellite is put into twice the radius of circular orbit $r = 2r$ then:-

$$v_o' = \sqrt{\frac{GM_E}{2r}} = v_o' = \frac{1}{\sqrt{2}}\sqrt{\frac{GM_E}{r}}$$

$$\boxed{v_o' = \frac{1}{\sqrt{2}} v_o}$$ thus satellites in higher orbits have lower orbital velocities.

.....

Q. No. 2 Part (II)(i) Constructive interference of light:-

It is the phenomenon in which crest of one wave falls on crest of other or trough on trough then resulting amplitude of wave of light is maximum this is called constructive Interference. Path difference:- (waves are inphase)

$$\boxed{d\sin\theta = m\lambda}$$

(ii) destructive interference:-

It is the phenomenon in which crest of one wave falls on trough of other wave ~~and~~ or trough on crest then this is called destructive interference. waves are out of phase and in opposite direction 180° angle.

Path difference:-

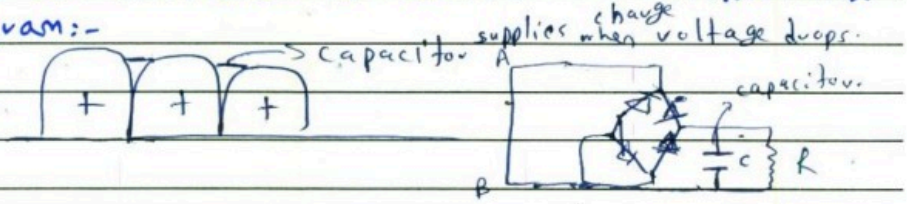
$$\boxed{d\sin\theta = \left(m + \frac{1}{2}\right)\lambda}$$

(Section B)

Q. No. 2 Part (iii) Function of capacitor in bridge wave rectifier:-

• Capacitor in bridge wave rectification helps to smooth out rectifying circuits by storing charge and releasing it when current drops reducing voltage fluctuations. It acts as a filter and smooth out pulsating D.C into common constant output this is called filtering. It ~~helps~~ charges when ~~current~~ current increases and discharges when current decreases. It helps to fill out the gaps between peaks of Rectified waveform and reduce ripple voltage.

Diagram:-



Q. No. 2 Part (iv) Self inductance:-

The phenomenon in which changing current in a coil induces Emf in the same coil is called self inductance. Changing current in coil causes changing magnetic flud which induces Emf in coil.

$E \propto \frac{\Delta I}{\Delta T}$, $E = L\frac{\Delta I}{\Delta T}$ so $\boxed{L = \frac{E\Delta T}{\Delta I}}$, It is also called back Emf.

SI Unit:-

SI unit of self inductance is Henry (H)

dependance on factors:-

(i) Number of turns of coil, $L \propto N$

(ii) Area of ~~of~~ cross section of coil, $L \propto A$

(iii) Nature of core material

(iv) Relative permiability of core material.

(Section B)

Q. No. 2 Part (v) Capacitive reactance:-

The opposition offered by capacitor to flow of A.C is called capacitive reactance.

$$X_c = \frac{1}{Cw}$$

Doubling frequency then X_c? :-

When we double the frequency the capacitive reactance becomes **half.**

Proof:-

$X_c' = \frac{1}{Cw}$, $w = 2\pi f$ put values:-

$X_c' = \frac{1}{C(2\pi f)}$ $f' = 2f$ then $X_c' = \frac{1}{C(2\pi 2f)}$;

$X_c' = \frac{1}{2C(2\pi f)}$, $\alpha_c' = \frac{1}{2Cw}$ $\boxed{\alpha_c' = \frac{1}{2}\alpha_c}$

so it becomes half.

Q. No. 2 Part (vi) X-rays in imaging of body internal structure:-

(i) α ray imaging in one of the oldest and common techniques for body imaging, they are used to find structure of bones, teeth, tissues etc.

(ii) α rays are strongly absorbed **by bones** since they contain calcium and are used to for **Shadowy and light image** of bone structure which helps to determine **fractures and bone issues.**

(iii) α-rays are also absorbed by fat tissues by lesser and we use contrast to increase brightness of image.

(iv) α-ray imaging thus provides structure of bone, tissue, teeth etc.

(Section B)

Q. No. 2 Part (vii) Pair production:-

A process in which a very highly energetic photon is converted into corresponding particle and antiparticle is called pair production.

Minimum energy:-

$\gamma = e^+ + e^-$

$hf = m_o c^2 + m_o c^2$, $\boxed{hf = 2m_o c^2}$

$E = m_o c^2$, $m_o = 9.1 \times 10^{-31}$ kg , $c = 3 \times 10^8$

$E = (9.1 \times 10^{-31})(3 \times 10^8)^2$

$E = 8.19 \times 10^{-14}$ J , ~~1ev = 1.6ato~~

1.6×10^{-19} J = 1eV

8.19×10^{-14} J = $\frac{1}{1.6 \times 10^{-19}} \propto 8.19 \times 10^{-14} = \boxed{0.511 \text{ MeV}}$

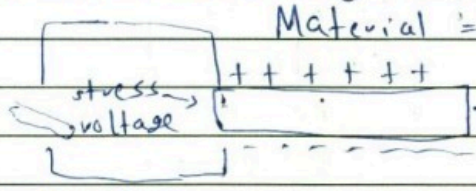
$hf = 2m_o c^2$ minimum energy required by photon for pair production.

$hf = 2(0.511) = \boxed{1.022 \text{ MeV}}$

Q. No. 2 Part (viii) Piezo electric effect:-

It is the ability of certain materials to generate Electric signals in response to stress.

Material = lead Zirconate titanate.



Applications:-

(i) It is used to generate ultrasound waves.

(ii) Electronic frequency generation and microbalances.

(iii) Production of high voltages.

Reverse Piezo electric effect:-

It is ability of certain materials to generate stress in response to electrical signals.

(Section B)

Q. No. 2 Part (ix) (i) Control rods:-

Control rods are basically safety rods which are used to absorb excess neutrons and ensure that only one neutron is used to carry another fission chain reaction. They are made of Boron and cadmium and ensure only one neutron per fission event to control fission reaction in reactor.

(ii) Moderator:-

Moderators basically slow down neutrons produced by fission. neutrons produced by fission are of high energy. and for fission Uranium 235 0.025ev energy neutrons are required so they increase probability of another fission chain reaction. they are made up of water and graphite.

.....

Q. No. 2 Part (x) Idea leaded by Red shift:-

Red shift leads to the idea that universe is expanding and galaxies are receeding away from earth.

Explanation:-

When astronomers look at light from faraway galaxies they observe that light ~~light~~ is ~~streng~~ stretched to longer wavelength when it travels through Expanding space means it has shifted to Red side of spectrum having long wavelength this the reason that galaxies are receeding away from earth and universe is expanding as galaxies are receeding awayfrom earth.

(Section B)

Q. No. 2 Part (xi) (a) **Mass defect:-**

The difference in the mass of individual nucleons and mass of isolated nucleus is called Mass defect. basically the Mass of nucleus is always less than sum of mass of nucleons it is made up of due to energy mass inter-conversion by nucleons.

"$\Delta m = Zm_p + (A-Z)m_n - M_{nucleus}$." → formula

(b) **binding energy:-**

It is the minimum amount of energy required to break nucleus into its constituent particles. higher the value of binding energy for each nucleon the higher the stability of nucleus.

Formula:-

$E = \Delta mc^2$ or packing fraction = $f = \frac{E}{A}$

Q. No. 2 Part (xii) (i) **Light damping:-**

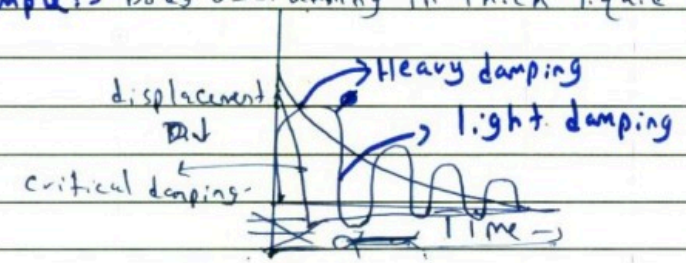
light damping gradually decreases the amplitude and energy of oscillating body and gradually returns body towards mean position.

Example: Pendulum stopping due to resistive forces.

(ii) **Heavy damping:-**

It returns the body to Equilibrium position very fast and does not even allow one oscillation.

Example:- Body oscillating in thick liquid like oil.



(Section B)

Q. No. 2 Part (xiii) Grating element:-

The distance between centres of two adjacent lines in diffraction grating is called **Grating element**. It depends on Number of lines and unit length.

Formula:-

$$d = \frac{L}{N}$$

where $\frac{L}{N}$ is number of lines per unit length.

$$d \propto L$$

$$d \propto \frac{1}{N}$$

Q. No. 2 Part (xiv) Effect of slit seperation on fringe spacing.

When we increase the slit ~~spe~~ seperation then fringe spacing **decreases**. Fringe spacing is inversely proportional to slit seperation :-

$Y = \frac{L\lambda}{d}$, $Y \propto \frac{1}{d}$ so when $\downarrow Y \propto \frac{1}{d\uparrow}$

Mathematical relation:-

$Y = \frac{L\lambda}{d}$, $Y \propto \frac{1}{d}$ So when ~~fringe spacing~~ slit seperation increase then fringde spacing decreases.

Example:-

If slit seperation is doubled then:-

$Y' = \frac{L\lambda}{2d}$, $Y' = \frac{1}{2}\frac{L\lambda}{d}$, $Y' = \frac{1}{2}Y$, ~~st~~ fringe spacing is halved.

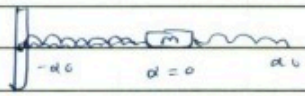
(Section C)

Q. No. 3 (Page 1) **Simple harmonic motion:-**

A type of oscillatory motion in which acceleration of body is directly proportional to displacement from mean position and always directed to mean position is called simple harmonic motion.

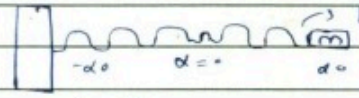
Mass Attatched to spring:-

- lets consider that a mass is attatched to a horizontal and frictionless spring.
- When mass is present at mean position it has no force acting on it.



- But when we apply force on spring then mass moves towards extreme position and extension produced in spring is directly proportional to force within elastic limit according to hookes law:-

$$F = Kx$$



$$K = \frac{F}{x}$$

K is called springs constant

unit $= Nm^{-1}$

(Section C)

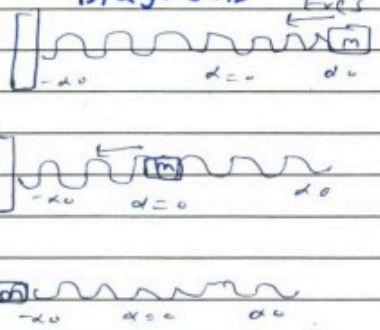
Q. No. 3 (Page 2) Restoring force:-

When body moves to extreme position a force acts on it and causes body to return back to mean position which is called **restoring force.**

$F_{res} = -K\alpha$

It is equal in magnitude to applied force but opposite in direction ⊖ sign represent opposite direction.

Diagram:-



According to newtons 2nd law:-

$F = ma$

$F = -K\alpha$

$ma = -K\alpha$

$a = \frac{-K\alpha}{m}$ ∴ $\frac{K}{\alpha}$ is constant.

$a = \text{constant}\ (-\alpha)$

$a \propto -x$ → Thus motion of mass attatched to spring is simple harmonic.

Angular frequency:-

$a = -\omega^2\alpha$

$a = \frac{-K\alpha}{m}$

$\frac{+K\alpha}{m} = +\omega^2\alpha$

(Section C)

Q. No. 3 (Page 3) $\omega^2 = \frac{K}{m}$, $\omega = \sqrt{\frac{K}{m}}$

Time period:-

$$T = \frac{2\pi}{\omega}$$

$$\omega = \sqrt{\frac{K}{m}}$$

$$T = \frac{2\pi}{\sqrt{\frac{K}{m}}} = \boxed{2\pi\sqrt{\frac{m}{K}}}$$

$\boxed{T = 2\pi\sqrt{\frac{m}{K}}}$ → Time period of mass attached attatched to spring.

frequency:-

$$\omega = 2\pi f$$

$$f = \frac{\omega}{2\pi}$$

$$\omega = \sqrt{\frac{K}{m}}$$

$$f = \frac{1}{2\pi}\sqrt{\frac{K}{m}}$$

$\boxed{f = \frac{1}{2\pi}\sqrt{\frac{K}{m}}}$ → frequency of mass attatched to spring.

(Section C)

Q. No. 4 (Page 1)

Electric potential:-

Electric potential energy per unit charge is called Electric potential.

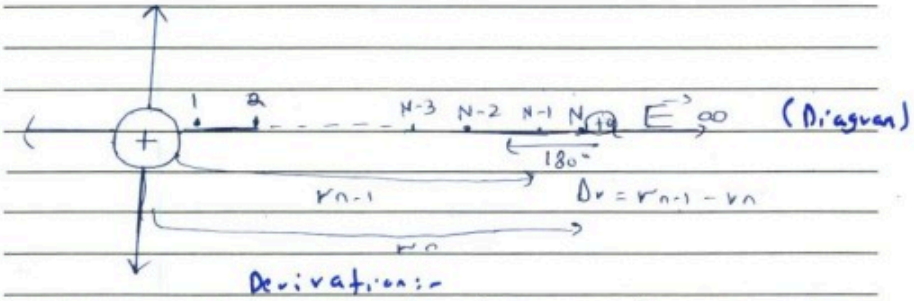
OR

Work done per unit charge is called Electric potential.

$$V = \frac{W}{Q} = \frac{\Delta U}{Q}$$

Electric potential

Electric potential due to a point charge.



(Diagram)

Derivation:-

- lets consider a point charge placed in Electric field of a source charge. Electric field is directed from positive to negative charge In order to move charge against electric field we need to do some work on it. As Electric field is not constant we divide distance into small patches where Electric field is constant.

$W = F \Delta r \cos\theta$

$F = Eq$

$W = Eq \Delta r \cos\theta$, $W = Eq \Delta r \cos 180°$

$\theta = 180°$, $W = -Eq \Delta r$

(Section C)

Q. No. 4 (Page 2) $E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r_{avg}^2}$, put values:-

$W_{n\to n-1} = -\frac{Q}{4\pi\varepsilon_0}\frac{1}{r_{avg}^2} \times q \times \Delta r$

find value of r^2_{avg} :-

$r_{avg} = \frac{r_{n-1} + r_n}{2}$

$\Delta r = r_{n-1} - r_n$

$r_{n-1} = \Delta r + r_n$ put value:-

$r_{avg} = \frac{r_n + r_n + \Delta r}{2}$

$r_{avg} = \frac{2r_n + \Delta r}{2} = \frac{2r_n}{2} + \frac{\Delta r}{2}$

$r_{avg} = r_n + \frac{\Delta r}{2}$

square on both side:-

$r_{avg}^2 = (r_n + \frac{\Delta r}{2})^2 = r_n^2 + \frac{\Delta r^2}{4} + r_n \Delta r$

$\frac{\Delta r^2}{4}$ is negligible as it is very small value:-

$r^2_{avg} = r_n^2 + r_n \Delta r$

$r^2_{avg} = r_n^2 + (r_n)(r_{n-1} - r_n)$

$r_{avg}^2 = r_n^2 + r_n r_{n-1} - r_n^2$

$\boxed{r_{avg}^2 = r_n r_{n-1}} \rightarrow (i)$

Put value:-

$W = -\frac{Qq}{4\pi\varepsilon_0(r_n r_{n-1})} \times (\Delta r)$; $\Delta r = r_{n-1} - r_n$

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

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

(Section C)

Q. No. 4 (Page 3) Multiplying

(-) sign :-

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

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

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

$W_{net} = W_{n \to n-1} + W_{n-1 \to n-2} + W_{2 \to 1}$

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

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

$W_{net} = \Delta U \Rightarrow$ Electric potential energy.

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

If we take charge from infinity then $r_n = \infty$

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

$\frac{1}{\infty} = 0$

$$W_{\infty \to 1} = \frac{Qq}{4\pi\varepsilon_0}\left(\frac{1}{r_1} - \frac{1}{0}\right)$$

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

So

$$\boxed{\Delta U = \frac{Qq}{4\pi\varepsilon_0}\left(\frac{1}{r}\right)}$$

↓ Electrical potential energy due to point charge.

Electric potential :-

$$V = \frac{\Delta U}{q}$$

$$V = \frac{Qq}{4\pi\varepsilon_0}\left(\frac{1}{r}\right) \times \frac{1}{q}$$

$$\boxed{V = \frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{r}\right)}$$

↓

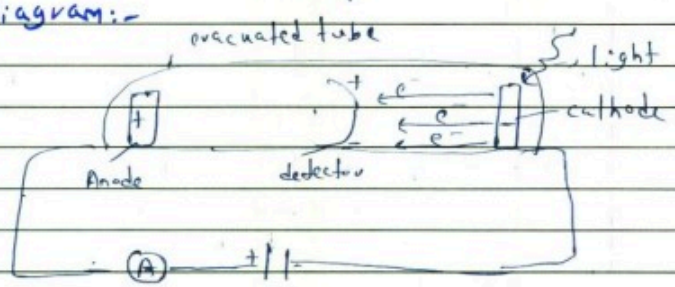
Expression for electric potential due to a point charge.

(Section C)

Q. No. 5 (Page 1) (i) Photo electric effect:-

The process of emission of electrons from a metal surface when light or Electromagnetic radiation of high frequency falls onto it is called photo electric effect.

Diagram:-



(ii) Threshold frequency:-

Minimum amount of frequency required for emission of electrons from metal surface is called Threshold frequency Represented by f_o.

Reason for no emission of electrons below threshold frequency:-

If $f < f_o$ then no electrons are emitted because light with high frequency would cause electrons ~~to gain~~ in material to gain sufficient energy to escape from metal surface As $E \propto F$ so If light doesn't have frequency equal or greater than threshold frequency then no Electrons are emitted since Electrons gain less energy from light to escape from metal

(Section C)

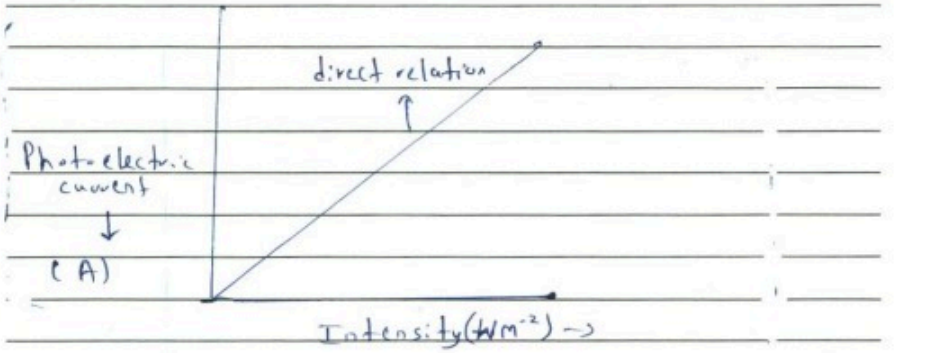
Q. No. 5 (Page 2) surface and keep remain bound in negative plate.

(iii) Effect of intensity of light on photo electric current:-

When we increase the intensity of light then photoelectric current increases due to increase in number of photoelectrons. higher intensity of light causes electrons in valence band to come out of it and increases the number of electrons thus which increases Photoelectric current.

Intensity of incident light↑ ∝ photoelectric current↑

Graph.



(Photoelectric current varies directly with intensity of light.

(Section C)

Q. No. 5 (Page 3)

(Section C)

Q. No. 6 (Page 1) (a) Uranium enrichment :-

The process or method to increase proportion of Uranium 235 to use it in fission chain reaction is called ~~Uran~~ Enrichment.

OR

It is a technique to increase quantity of Uranium 235 for its use in nuclear fission.

- ~~Unit~~ Uranium is enriched to about 3-5%. in nuclear reactors.

• Reason for uranium enrichment:-

- Uranium has two isotopes :-
- Uranium 238 which is found naturally in 99.3%.
- Uranium 235 which is found naturally in 0.7%.
- Since the quantity of uranium is ~~two~~ too low for fission chain reaction so uranium enrichment is done to increase it **proportion and quantity** for fission reaction in order to release large amount of energy in nuclear reactors.
- Uranium 238 is not fissile it absorbs neutrons to form Plutonium 239 which is fissile.
- Uranium 235 is fissile and can absorb neutron ~~to~~ to undergo fission.

Methods of Enrichment:-

(i) Gas centrifugation

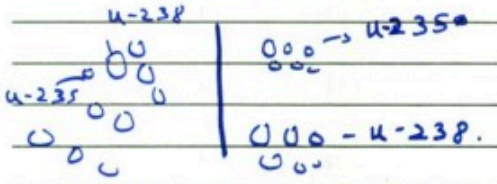
(Section C)

Q. No. 6 (Page 2) (ii) Membrane seperation

(iii) Laser ionization.

- Gas seperation and Membrane seperation seperate U-235 from U-238.

- Laser ionization excites U-235 atoms for seperation.



(Membrane seperation)

(b) Given:-

$\Delta N = 100$ nuclei

$N = 700$ nuclei

$\Delta t = 300$ seconds $= 5$ min

$\lambda = ?$

Formula:-

$$\frac{\Delta N}{\Delta T} = -\lambda N$$

putting values and Rearranging:-

$$\frac{\Delta N}{\Delta T} \div N = -\lambda \quad , \quad \frac{\Delta N}{\Delta T} \times \frac{1}{N} = -\lambda$$

(Section C)

Q. No. 6 (Page 3) $\frac{100}{300} \times \frac{1}{700} = 4.76 \times 10^{-4}\ s^{-1}$

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

For activity :-

Formula:-

$A = -\lambda N$

putting value of decay constant:-

$A = (4.76 \times 10^{-4})(700) = -0.33\ Bq$

$A = -0.33\ Bq$

Thus activity of element is -0.33 Bq.