$\lambda = ?$ $A = ?$ $A = \lambda N$

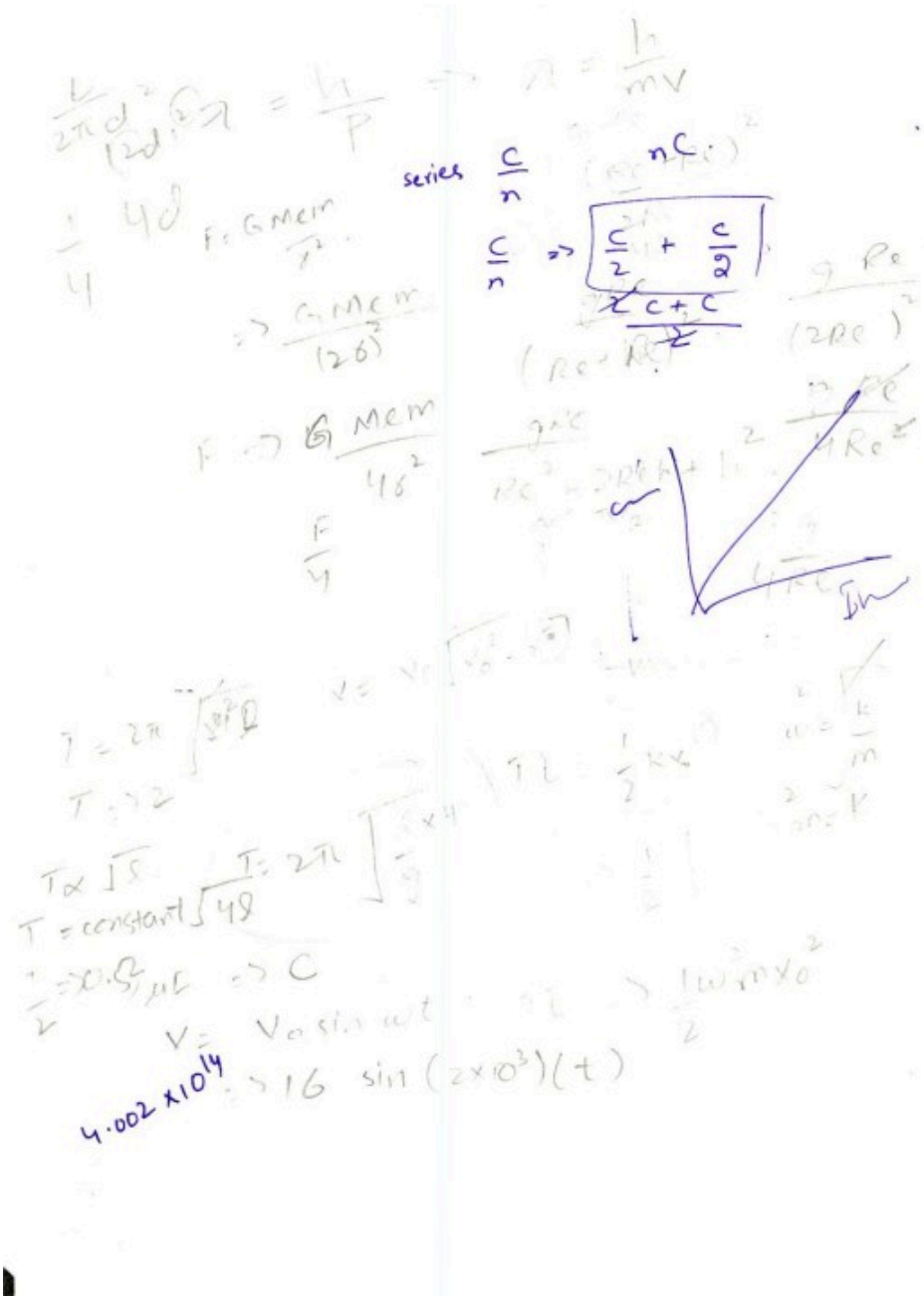
$\lambda = \frac{\Delta N}{\Delta t} \times N$ $T_{1/2} = \frac{0.693}{\lambda}$

$N = N_0 e^{-\lambda}$ $700 \longrightarrow 350 \longrightarrow$

by $\frac{N}{N_0} = e^{-\lambda t}$






series
C/n
nC
n C/n =>
C/2 + C/2
2C + C
T = constant √48
V = V0 sin ωt
4.002 x 10^14
= 16 sin (2x10^3)(t)

(Section B)

Q. No. 2 Part (i)

Given: Time period : 0.4s displacement = 4cm

acceleration = ?

Solution:-

$T = \frac{1}{f}$ $f = \frac{1}{T} \Rightarrow \frac{1}{0.4s}$ $\boxed{f = 2.5\,Hz}$

As we know:-

acceleration $= a = -\omega^2 x$

As $\omega = 2\pi f$ so $a = -(2\pi f)^2 (x)$

$a = -(2 \times 3.14 \times 2.5)^2 (0.04m)$ (neglecting -ve sign as it only shows direction)

$\boxed{a = 9.86\,ms^{-2}}$

.....

Q. No. 2 Part (ii)

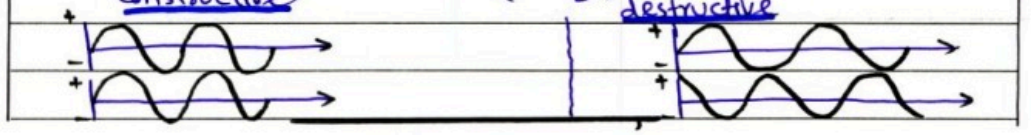
Interferance of light:-

→ Constructive interferance is the interaction of light waves such that their crests fall on crest and trough fall on trough which resultantly increase the amplitude.

path difference $= m\lambda$ $(m = 0, \pm1, \pm2 \ldots)$

→ for destructive interferance we say that it is the interaction in which crest fall on trough and vice versa which in result decrease the amplitude of resultant hybrid wave.

path difference $= \left(m + \frac{1}{2}\right)\lambda$ $(m = 0, \pm1, \pm2 \ldots)$



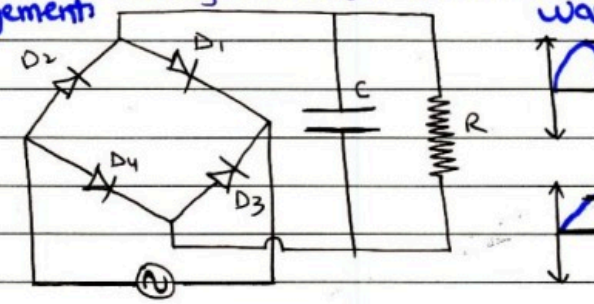
(Section B)

Q. No. 2 Part (iii)

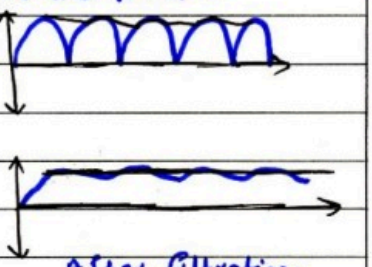
Capacitor and Bridge rectifier:-

The function of capacitor in bridge rectifier is **filtering** pulsating DC into pure DC. During rectification pulsating DC is produced which is converted into pure dc by attaching capacitor which stores current when it is on peak and slowly discharges when dawnfall occurs.

Arrangement:



Wave forms:-



After filtration.

Q. No. 2 Part (iv)

Feild strength "g" at height 1500km:-

As we know for height above surface of Earth the formula is:-

$$g = \frac{G M_e}{(R_e + h)^2}$$

$$g = \frac{(6.67 \times 10^{-11})(6 \times 10^{24})}{[(6.4 \times 10^{6}) + (1500 \times 10^{3})]^2}$$

$$g = \frac{4.002 \times 10^{14}}{6.241 \times 10^{13}}$$

$$g = 6.41 \ ms^{-2}$$

So for height **1500km** g will be **6.41ms^{-2}**

(Section B)

Q. No. 2 Part (v)

Relation between absolute temperature and avg K.E:-

$P = \frac{mN}{3V} \langle v^2 \rangle$ which becomes $P = \frac{2}{3} N_o \langle K.E \rangle$

As we know $PV = nRT$ also $PV = NkT$

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

$PV = \frac{1}{3} mN \langle v^2 \rangle$

$NkT = \frac{1}{3} mN \langle v^2 \rangle$

$NkT = \frac{2}{3} mN \langle \frac{1}{2} v^2 \rangle$

$kT = \frac{2}{3} m \langle \frac{1}{2} v^2 \rangle$

$T = \frac{2}{3k} \langle \frac{1}{2} mv^2 \rangle$

$T = \frac{2}{3k} \langle K.E \rangle$

$T \propto \langle K.E \rangle$

.....

Q. No. 2 Part (vi)

X-Rays and internal body structures:-

→ For simple observation X-Rays are targeted to the body organ under examination. In human bones, due to calcium it absorbs major quantity of x-Rays and cast a shadow in the result however flesh and skin are not able to absorb these x-Rays so they appear translucent. Due to this minor cracks and breakage are diagnosed by using x-Ray.

→ But for soft bones and complex examination, constrast is used in x-Rays by changing the concentration of x-Rays targeted physicians and doctors get a much precise image of body structures. By increasing or decreasing concentrations the image formed shows different results each time helping out in complex diagnostic procedures.

(Section B)

Q. No. 2 Part (vii)

Pair production is defined as a process in which photon is converted into two subatomic particles. Law of Conversation of momentum, Energy as well as charge occur. This happens when high energy photon pases near through a nucleus.

For positron, electron pair.

$$E_{(photon)} = energy_{(e)} + energy_{(p)}$$

$$hf = (m_0v^2 + K.E_e)(m_0v^2 + K.E_p)$$

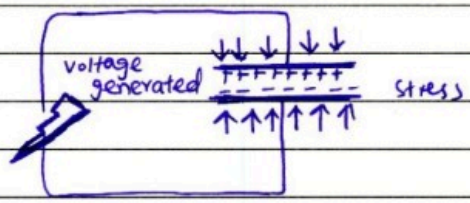
For pair production there should by $2m^0c^2$ energy of photon, which is approximately 1.02 MeV and one particle must have 0.51 MeV energy. Further energy is converted into K.E of particle.

.....

Q. No. 2 Part (viii)

Piezoelectric effect:-

Piezoelectric effect is defined as the production of external electric field in responce to applied mechanical stress on piezoelectric material (like PZT and Quartz)



Applications:-

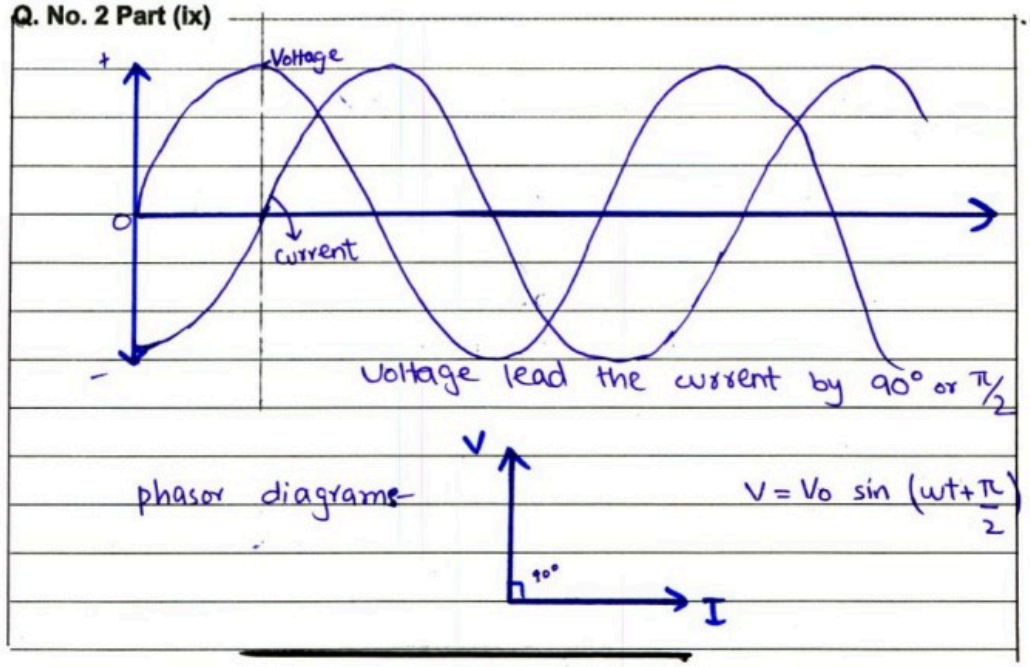
→ Useful in production of ultrasound waves.

→ Useful in production and utilization of microbalances.

→ Can be used in flow meter on industrial scale.

(Section B)

Q. No. 2 Part (ix)



Q. No. 2 Part (x)

Red shift :-

Red shift shown by a star lead to the concept of Expanding universe theory. we have some ideal spectrums (emission) of elements present on Earth but when we examine the same element spectrum coming from other stars or planents, we observe that the pattern is almost same but the difference is in position, they are lightly shifted toward red line. If same shifting occurss toward blue line we say that the same planet is coming near to us but for universe it always shift toward red line. This shif of spectrum is known as red. shift.

(Section B)

Q. No. 2 Part (xi)

(a) **Mass defect:-**

The change in mass of nucleons collectively in a nucleus and the sum of individual nucleons is known as mass defect. If we have a nucleus of carbon with 12 nucleons according to simple mathematics the mass of nucleus should be more than 12 amu but it is exactly 12amu.

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

(b) **Binding energy:-**

The amount of energy required to break a nucleus into its components (neutron and proton) is known as binding. The mass lost in formation of nucleus is converted into binding energy.

$$E = \Delta m c^2$$

Q. No. 2 Part (xii)

Factors effecting g:-

As we know:-

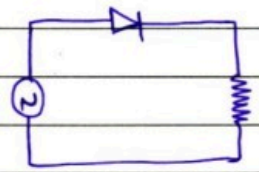
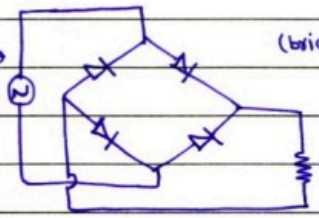
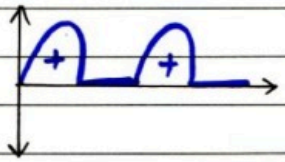
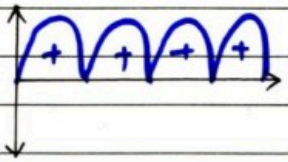
$$g = G\frac{M}{(R+h)^2} \quad \text{so:- } g \propto M, \; g \propto \frac{1}{(R+h)^2}$$

According to this equation, gravitational field around a planet just depends upon two factors:-

- **Mass of planet:-** means each and every thing with different masses have to face same amount of gravitational field.
- **distance:-** The second factor is the distance between object and Radius of planet. The more the distance is the less gravitational field it will have to face.

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Q. No. 2 Part (xiii)

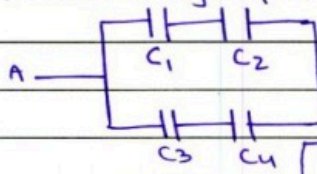
Half wave rectification.	Full-wave rectification.
→ Only one diode is used.	→ Four diode are used.
→ 	→  (bridge rectifier)
→ Wave form obtained. 	→ Wave form obtained 

.....

Q. No. 2 Part (xiv)

Equivalence capacitance:-

First of all naming capacitors:-



C_{eq_1} between C_1 and C_2

C_{eq_1} (as in series)

$$\frac{1}{C_{eq_1}} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\frac{1}{C_{eq_1}} = \frac{C_1+C_2}{C_1C_2}$$

$$\boxed{C_{eq_1} = C_1C_2 / C_1+C_2}$$

C_{eq_2} between C_3 and C_4

As in series.

$$\frac{1}{C_{eq_2}} = \frac{1}{C_3} + \frac{1}{C_4}$$

$$\frac{1}{C_{eq_2}} = \frac{C_3+C_4}{C_3C_4}$$

$$C_{eq_2} = \frac{C_3C_4}{C_3+C_4}$$

For final eq Capacitance:- (parallel)

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

$$= \frac{C_1C_2}{C_1+C_2} + \frac{C_3C_4}{C_3+C_4}$$

As $C_1=C_2=C_3=C_4$

$$= \frac{C^2+C^2}{C+C} \Rightarrow \frac{2C^2}{2C} \Rightarrow \boxed{C}$$

(Section C)

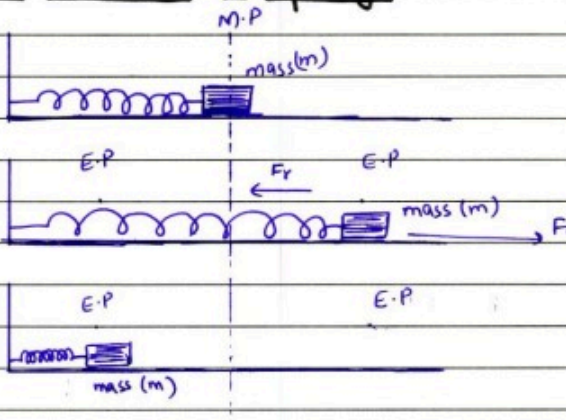
Q. No. 3 (Page 1)

Simple Harmonic Motion:-

Simple Harmonic motion is defined as a specific vibratory motion / periodic motion of a body where acceleration is directly proportional to displacement covered by the object and always directs toward mean position.

$a \propto -x$

Mass attached to Spring:-



Consider a mass attached to a spring and have no friction with the surface. When there is no force applied on it, the body will stays at Mean position. when we apply external force to the body whose magnitude is ma. The object will cover distance x_0 and comes to the extreme position. At extreme position A restoring force start to act upon it and is directed

(Section C)

Q. No. 3 (Page 2)

toward Mean position.

$F_{(applied)} = ma$

$F_{(restoring)} = -Kx$ (Applying Hooke's Law)

Now when the object comes to the mean position it has acquired a velocity v and according to newton's first law of motion and inertia it will travel toward second extreme position until again restoring force not acts upon it.

Ideally when there is no friction, this whole scenario continues but physically damping occurs and after some time object will have no velocity at all and it will became at rest

Now,

$F_{restoring} = F_{(applied)}$

$-Kx = ma$

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

now K is spring constant which tells about stiffness about string and m is mass. Both are constant so.

$a = (constant)(-x)$

$\boxed{a \propto -x}$

For value of w=

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

(Section C)

Q. No. 3 (Page 3)

$a = \omega^2 x = \frac{k}{m} x$

$\omega^2 = \frac{k}{m}$ $\qquad \omega = \sqrt{\frac{k}{m}}$

Time period:-

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

$\omega = 2\pi \times \frac{1}{T}$

$T = 2\pi \times \frac{1}{\omega}$

$$T = 2\pi \times \sqrt{\frac{m}{k}}$$

Frequency:-

$f = \frac{1}{T}$

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

Dependency:- (T and f)

It only depends upon:

(i) Spring constant

(ii) mass of object.

(Section C)

Q. No. 4 (Page 1)

Young's Double Slit Experiment:-

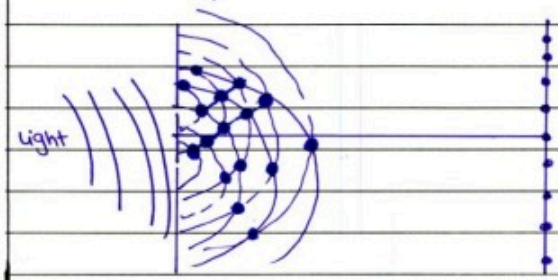
In 20th century, A physicist conducted an experiment named as Young's Double Slit experiment as his name was Thomas Young. He used this experiment to prove the wave nature of light waves. Initially, he utilized sunlight as a source of light due to which results were not so confined but after that many types of monochromatic light rays were used which showed consistent and precise results.

Apparatus:-

Thomas Young used sunlight and pass it through a single slit to make it partially coherent. After that he passed that wave from double slits with distance d in between (slit spacing). He concluded that the center of screen is always maxima showing however a pattern of maxima and minima is showed afterward.

The conditions for this experiment were:-

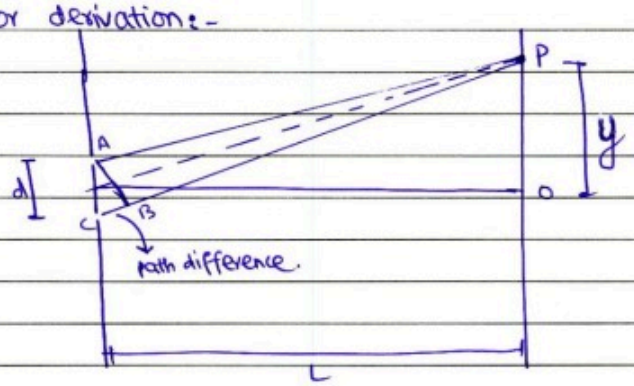
→ Coherent light source.
→ Monochromatic light.
→ dark place so no environmental light disturb it.



(Section C)

Q. No. 4 (Page 2)

For derivation:-



Suppose light from both slits occur on point P.

so path difference

$$\frac{\text{path difference}}{d} = \cos\theta$$

$$\boxed{\text{path difference} = d\cos\theta}$$

For Constructive interference

$$m\lambda = d\sin\theta.$$

For smaller angles $\sin\theta \approx \tan\theta$.

$$m\lambda = d\tan\theta.$$

$$m\lambda = d\frac{y}{L}$$

$$\boxed{y = m\lambda\frac{L}{d}}$$

(Section C)

Q. No. 4 (Page 3)

For destructive interference:-

$$y = \left(m+\frac{1}{2}\right)\lambda\frac{L}{d}$$

Fringe spacing:-

→ Between maxima.

$$\Delta y = y_{m+1} - y_m$$

$$= (m+1)\lambda\frac{L}{d} - m\lambda\frac{L}{d}$$

$$= \lambda\frac{L}{d}(m+1-m)$$

$$\boxed{\Delta y = \lambda\frac{L}{d}}$$

→ Between ~~same~~ minima.

$$\Delta y = y_{m+\frac{1}{2}+1} - y_{m+\frac{1}{2}}$$

$$= \left(m+\frac{1}{2}+1\right)\lambda\frac{L}{d} - \left(m+\frac{1}{2}\right)\lambda\frac{L}{d}$$

$$\boxed{\Delta y = \lambda\frac{L}{d}}$$

The fringe spacing remains same for both maxima and minima.

(Section C)

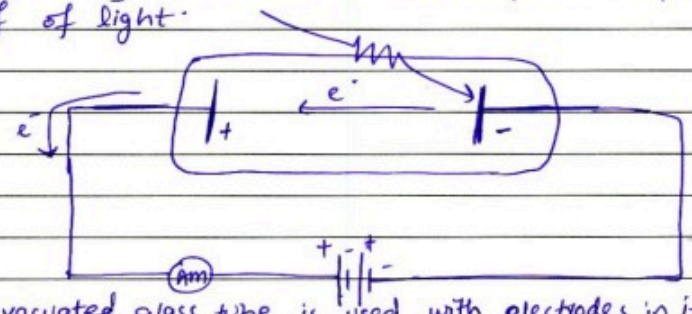
Q. No. 5 (Page 1)

~~RL Series Circuit:-~~

~~Diagram:-~~

Photoelectric Effect:-

Photoelectric effect is defined as the production of photoelectric current due to the emission of photoelectrons. photoelectrons are electrons emitted by metal surface when exposed to specific f of light.



Evacuated glass tube is used with electrodes in it when light is thrown on metal surface electrons are excited and removes from surface

No emission of photoelectrons:-

This happens due to work function.

Work function ϕ is defined as the energy required to the electron for breakage of bond between it and metal surface.

Einstein further evaluated this concept by an equation:-

$$\text{Energy} = hf_o + K.E$$

In the equation Energy shows the f of light. hf_o is work function and K.E is the K.E of electron. f_o is the threshhold frequency which is specific

(Section C)

Q. No. 5 (Page 2)

to that specific element.

$$E = hf_o + K.E$$

$$hf = hf_o + K.E.$$

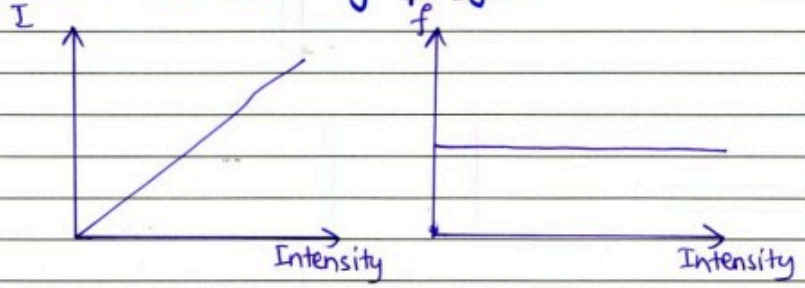
$$K.E = hf - hf_o$$

If $f = f_o$ $K.E = 0$

If $f > f_o$ $K.E > 0$

If $f_o < f$ No effect on metal surface.

Current and Intensity of light:-

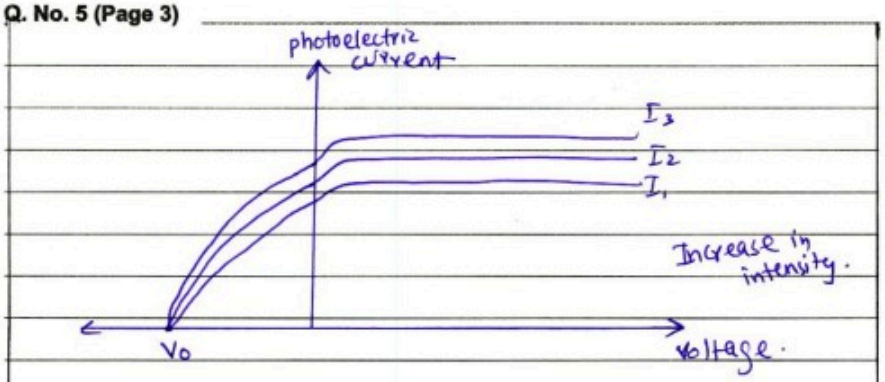


Intensity ∝ Current.

According to classical physics, Intensity has effect on frequency but this idea was made wrong by plank's theory. Intensity increase means number of photons or light packets increase which then increase the number of photoelectron emitted. It has no effect on voltage as it is linked with K.E.

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Q. No. 5 (Page 3)



for increase in voltage.

we say.

$E = hf$.

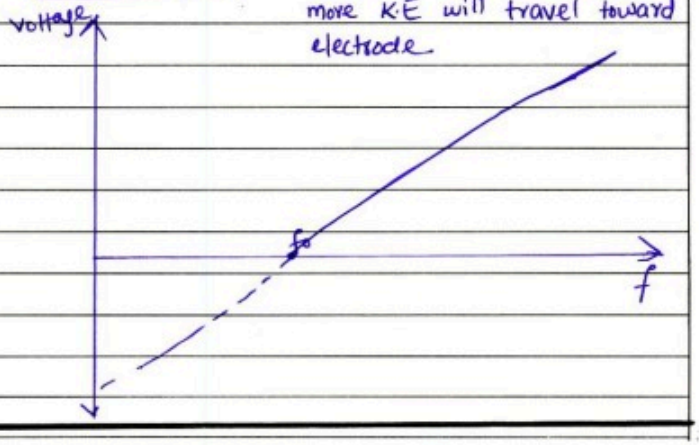
$eV_o = hf$

e and h are constant.

$V_o \propto f$

when we increase f the V_o of circuit as well as K.E of electrons also change.

when potential is reversed V_o only electrons with more K.E will travel toward electrode.



(Section C)

Q. No. 6 (Page 1)

(a) Enrichment:-

Enrichment is defined as:-

"Increase in the concentration of fissile isotope by processing non-fissile isotope of it which will then become favourable for a nuclear or radioactive decay reaction."

In nature, a compound can have more than one isotope and from which one can do decay reaction or fission reaction while other can't do soo. But due to less natural abundancy and limitation of minimum or critical mass for fission reaction we have to initially enrich the other isotope and then use it in the reaction.

Uranium enrichment:-

Like in nature Uranium-238 has a great abundancy of 99.7% almost but it is not fissile but due to enrichment of uranium-238 we can increase the concentration of Uranium-235 which is fissile and only occur 0.3% in nature. For critical mass distribution and fusion reaction we must have 3-5% uranium enriched.

This Uranium enrichment is done by two processes.

→ Gas diffusion
→ Gas centrifuge

Note:- We can also obtain plutonium from U-238 by neutron

(Section C)

Q. No. 6 (Page 2)

(b) **Given:-**

Initial mass = 700 nuclei = No

Undecayed mass = 100 nuclei = N

time = 5 min. = t

To find:-

Decay constant = ?

Activity = ?

Formulas:-

$\frac{N}{No} = e^{-\lambda t}$, $A = \lambda N$

Solution:-

First of all finding out decay constant.

As we know:

$$\frac{N}{No} = e^{-\lambda t}$$

After further calculation.

$$\log \frac{N}{No} = -\lambda t$$

$$-\lambda = \left(\log \frac{N}{No}\right) / (t)$$

(We take neglecting negative sign as it only shows the N is decreasing)

$$-\lambda = \left(\log \frac{100}{700}\right) \div (5)$$

~~$-\lambda = 9.225$~~

~~$\lambda = 9.225$~~

(Section C)

Q. No. 6 (Page 3)

~~For Half life we can use:-~~

~~$T_{1/2} = 0.693$~~

~~$= 9.225 m^{-1}$~~

~~$T_{1/2} = 0.075$~~

$$-\lambda = \frac{\log 100 - \log 700}{5}$$

$$-\lambda = \frac{2 - 2.84}{5}$$

$$+\lambda = \frac{+0.84}{5}$$

$$\boxed{\lambda = 0.16\ min^{-1}}$$

For Activity using formula:-

$$A = \lambda N$$

~~$A = (0.16)(t)$~~

$$A = (0.16\ min^{-1})(100)$$

$$A = (2.66 \times 10^{-3}\ s^{-1})(100)$$

$$\boxed{A = 0.266\ Bq}$$

For half life.

$$T_{1/2} = \frac{0.693}{\lambda}$$

$$T_{1/2} = \frac{0.693}{0.16 min^{-1}}$$

$$\boxed{T_{1/2} \approx 4.1\ min}$$