Exercise I

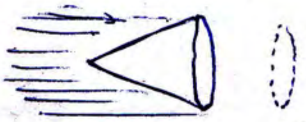
1> $E = \phi + KE_{max}$

$$\cancel{\frac{hc}{\lambda_0}} \quad \underbrace{\frac{hc}{\lambda}}_{?} = \underbrace{\frac{hc}{\lambda_0}}_{230\ nm} + \underbrace{KE_{max}}_{1.5\,eV} \qquad hc = 1242\ eV\text{-}nm$$

$\Rightarrow \boxed{\lambda = 180\,nm}$

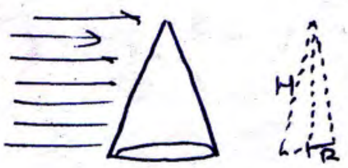
2> for perfect absorption & a parallel beam

→ Radiation force = $\frac{I}{c} \times$ projected area



$= \frac{I}{c} \times \pi R^2$

3> Similar to previous one



Radiation force $= \frac{I}{c} \times \frac{1}{2} H \cdot 2R$

$= \frac{I}{c} HR$

4> The potential acquired by the sphere will be the stopping potential because once it acquires that potential, the photoelectrons ejected from it are not able to escape to infinity and hence fall back to it

$E = \phi + KE_{max}$

$\frac{hc}{\lambda} = \phi + eV_s$

$hc = 1242\ eV\text{-}nm$

$\lambda = 200\ nm$

$\phi = 2\,eV$

$\Rightarrow \boxed{V_S = 4.21\,V}$

5> "d" is the incorrect statement

Since X ray photons have lower wavelength than visible photons, hence they are more energetic

6> $\because$ $\lambda_{\text{debroglie}} = \frac{h}{p}$

$\Rightarrow$ The 3 particles have same momentum

also $K = \frac{1}{2}mv^2 = \frac{p^2}{2m}$

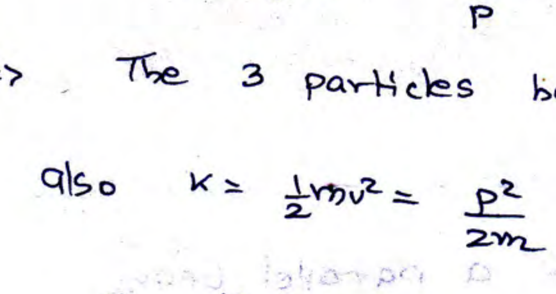
$\Rightarrow K \propto \frac{1}{m}$

$\Rightarrow \because m_e < m_p < m_\alpha$

$\Rightarrow K_e > K_p > K_\alpha$

$\Rightarrow \boxed{E_1 > E_3 > E_2}$

7>



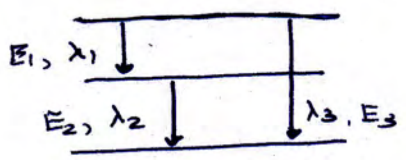
Energy received = (Intensity x Area) x time

$= \frac{P}{4\pi l^2} \times 4\pi d^2 \times t$

$= \frac{Pd^2 t}{l^2}$

no. of photons received $= \frac{E}{\left(\frac{hc}{\lambda}\right)} = \frac{\left(\frac{Pd^2t}{l^2}\right)}{\left(\frac{hc}{\lambda}\right)} = \frac{P\lambda d^2 t}{hcl^2}$

8>



$$E_3 = E_1 + E_2$$

$$\Rightarrow \frac{hc}{\lambda_3} = \frac{hc}{\lambda_1} + \frac{hc}{\lambda_2}$$

$$\Rightarrow \boxed{\lambda_3 = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}}$$

9>

$$r = \frac{mv}{qB} \quad , \quad mvr = \frac{nh}{2\pi}$$

$$\Rightarrow \cancel{m}\left(\frac{qBr}{m}\right) r = \frac{nh}{2\pi}$$

$$r = \sqrt{\frac{nh}{2\pi eB}}$$

$$r_{min} = \sqrt{\frac{h}{2\pi eB}}$$

10>

$$\frac{1}{\lambda} = R\left(1 - \frac{1}{n^2}\right)$$

$$\frac{1}{\lambda R} = 1 - \frac{1}{n^2}$$

$$\Rightarrow \frac{1}{n^2} = 1 - \frac{1}{\lambda R}$$

$$\Rightarrow n^2 = \frac{\lambda R}{\lambda R - 1} \Rightarrow n = \sqrt{\frac{\lambda R}{\lambda R - 1}}$$

11> Shortest wavelength of Lyman

$$\frac{1}{\lambda} = R\left(\frac{1}{1^2} - \frac{1}{\infty^2}\right)$$

$$\Rightarrow \boxed{\frac{1}{x} = R}$$

$$\Rightarrow \boxed{x = \frac{1}{R}}$$

1st member of Balmer series

$$\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$$

$$\frac{1}{y} = R \cdot \frac{5}{36}$$

$$y = \frac{36}{5R} \Rightarrow \boxed{y = \frac{36}{5}x}$$

12> $\lambda_{eff} = \lambda_1 + \lambda_2$

$$= \frac{1}{T_{mean_1}} + \frac{1}{T_{mean_2}}$$

$$= \frac{1}{1620} + \frac{1}{405}$$

for decay of 3/4 th sample => $T = 2 \times T_{half}$

$$= 2 \times \frac{\ln 2}{\lambda_{eff}}$$

$$= 2 \times \frac{\ln 2}{\frac{1}{1620} + \frac{1}{405}}$$

$$= 449 \text{ years}$$

13> Temperature has No effect

14> after 2 half lives the sample is 1/4th of original sample => activity becomes 1/4th of original activity

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15> Probability of survival $= P = e^{-\lambda t}$

$$= e^{-\lambda \times 2 \cdot t_{1/2}}$$

$$= e^{-\cancel{\lambda} \times 2 \times \frac{\ln 2}{\cancel{\lambda}}}$$

$$= e^{-\ln 4}$$

$$= \frac{1}{4}$$

=> Probability of disintigration $= \frac{3}{4}$

16> Power $= vi = (100\times10^3)\times(10\times10^{-3})$

0.2 % Energy $\longrightarrow$ x ray

$\Rightarrow$ 99.8 % Energy $\longrightarrow$ heat

$\Rightarrow$ Rate of heating $= \frac{99.8}{100}$ (Power)

$= \frac{99.8}{100} \times 1000$ Joules/sec

$= \frac{99.8}{100} \times \frac{1000}{4.18}$ Cal/sec

$= 238.75$ Cal/sec

17> $\sqrt{f} = a(z-b)$

$\sqrt{f} = \sqrt{\frac{3Rc}{4}}\,(z-1)$

$f = \frac{3Rc}{4}(z-1)^2$

$\frac{\cancel{c}}{\lambda} = \frac{3R\cancel{c}}{4}(z-1)^2$

$\Rightarrow z = 1 + \sqrt{\frac{4}{3R\lambda}}$ $\longrightarrow 1.785\times10^{-10}$ $\longrightarrow 1.09\times10^{7}$

$\Rightarrow \boxed{z = 27}$

18> high thermal conductivity to ensure that the heat is easily dissipated and high atomic No. ensures efficiency of X-ray production

19>
$$\sqrt{f} = a(31-1)$$
$$\sqrt{f'} = a(51-1)$$
$$\frac{f'}{f} = \left(\frac{5}{3}\right)^2 \Rightarrow \boxed{f' = \frac{25}{9}f}$$

20>
$$Rn \xrightarrow[55sec]{} Po \xrightarrow[0.016sec]{} Pb \xrightarrow[10.6hr]{} Bi$$

∵ Rn has half Life of 55 seconds, most of it would be converted to Po in 5 mins and even Po would have converted to Pb since the half Life is very very small but the lead ~~~~ ~~~~ would be mostly intact because of high half Life
⇒ greatest mass → Lead

1>
$$n = \frac{\text{Power}}{\text{Energy of Each photon}}$$
Each photon → E_0

$$\Rightarrow n \propto \frac{1}{E_0}$$

∵ $E_{0\,blue} > E_{0\,red}$

~~⇒ n_{red} <~~

$n_{blue} < n_{red}$

Q22> Current = $\left(\frac{\text{Power}}{E_0}\right) \times \text{efficiency} \times e$

E_0 → Energy of each photon

$$i = \frac{P}{\left(\frac{hc}{\lambda}\right)} \times \eta \times e$$

$$\Rightarrow \eta = \frac{ihc}{\lambda P e}$$

$i = .16 \mu A$
$\lambda = 5000 \mathring{A}$
$P = 10^{-3}$
$e = 1.6 \times 10^{-19}$

$$\Rightarrow \eta = .04 \times 10^{-2}$$

$$\Rightarrow \eta = .04 \%$$

Q23 $KE = \frac{p^2}{2m}$

$\Rightarrow \quad p = \sqrt{2m(KE)}$ → eV → accelerating voltage

$\Rightarrow \quad p \propto \sqrt{m}$

$\Rightarrow \quad P_p > P_e$

$\lambda = \frac{h}{p} \quad \Rightarrow \quad \boxed{\lambda_p < \lambda_e}$

Q24 : Cannot be predicted because momentum does not change in magnetic field whereas in Electric field the momentum may increase, decrease or remain same.
hence "D"

Q25 $\frac{hc}{\lambda} = \phi + K$

$\frac{hc}{\lambda'} = \phi + K'$

$\lambda' \rightarrow \left(\frac{3\lambda}{4}\right)$

$\Rightarrow \frac{4}{3}\left(\frac{hc}{\lambda}\right) = \phi + K'$

$\Rightarrow \frac{4}{3}(\phi + K) = \phi + K'$

$\Rightarrow \boxed{K' = \frac{\phi}{3} + \frac{4K}{3}}$

$\Rightarrow K' > \frac{4K}{3}$

Q26 $h\nu = \phi + eV_s$

$2h\nu = \phi + eV_s'$

$\Rightarrow 2(\phi + eV_s) = \phi + eV_s'$

$\Rightarrow \phi + 2eV_s = eV_s'$

$\Rightarrow \boxed{V_s' = 2V_s + \frac{\phi}{e}}$

Q27 $K = \frac{p^2}{2m} \Rightarrow p = \sqrt{2mK}$

$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mK}}$

$K = K_0 + eV$

$= 100\ eV + e \times 50V$

$= 150eV$

$= \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-34} \times 150 \times 1.6 \times 10^{-19}}}$

$= 1\ \mathring{A}$

Q28: $\lambda = \frac{h}{p} \Rightarrow p = \frac{h}{\lambda} = \frac{h}{.01 \times 10^{-10}}$

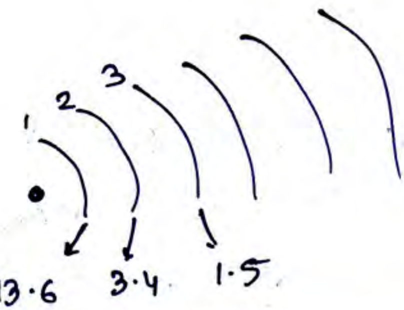
$\Rightarrow p = 10^{12} h$

Q29: $E = \phi + eV_s$

$= 1.7\,eV + e \times 10.4$

$= 12.1\,eV$

So 12.1 is obtained by jump from $3 \rightarrow 1$



Q30: A photon is either absorbed by an electron or it is not. ~~on~~ And if absorbed, it is completely absorbed. So one photon can eject only one electron

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Q31

$$\frac{N_1 = N_0 e^{-10\lambda_0 t}}{N_2 = N_0 e^{-\lambda_0 t}}$$

$$\frac{N_1}{N_2} = e^{-9\lambda_0 t}$$

$\rightarrow 1/e$

$\Rightarrow e^{-1} = e^{-9\lambda_0 t}$

$\Rightarrow 9\lambda_0 t = 1 \Rightarrow \boxed{t = \frac{1}{9\lambda_0}}$

Q 32: ~~Because~~ If the total Energy falling is increased and Simultaneously the Energy of Each photon is also increased → That means that total number of photons falling on the metal remains the same

$\Rightarrow$ No increase in current

Q33 $N = N_0 e^{-\lambda t}$

$$\frac{N}{N_0} = e^{-\lambda\left(\frac{1}{\lambda}\right)}$$

$$\Rightarrow \frac{N}{N_0} = \frac{1}{e}$$

Q34 $\because$ increasing the distance only changes the intensity and has No effect on frequency, it has no effect on stopping potential

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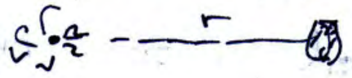
Q35 : $\because$ $i \propto I$ ↳ intensity

& $I = \dfrac{P}{4\pi r^2}$



$\Rightarrow$ $\boxed{i \propto \frac{1}{r^2}}$ hence "D"

Q36 $\because$ $\dfrac{hc}{\lambda_1} = \phi + K_1$

$$\frac{hc}{\lambda_2} = \phi + K_2$$

$$\Rightarrow \overset{2}{\frac{\lambda_1}{\lambda_2}} = \frac{\phi + K_2}{\phi + K_1}$$

$$\Rightarrow 2\phi + 2K_1 = \phi + K_2$$

$$\Rightarrow \boxed{K_2 = 2K_1 + \phi}$$

Q37 $hf = \phi + eV$

$\Rightarrow \cancel{V =}$

$hf_0 = \phi + e \times 0$

$\Rightarrow \boxed{\phi = hf_0}$

$hf_1 = \phi + KE_{max}$

$hf_1 = hf_0 + KE_{max}$

$\Rightarrow \boxed{KE_{max} = h(f_1 - f_0)}$

Q38 $E = \phi + KE_{max}$

$E - \phi = \frac{1}{2} mv^2$

$\Rightarrow v = \sqrt{\frac{2}{m}(E - \phi)}$

$\frac{v_1}{v_2} = \sqrt{\frac{E_1 - \phi}{E_2 - \phi}}$

$\frac{v_1}{v_2} = \sqrt{\frac{2\phi - \phi}{5\phi - \phi}}$

$\boxed{\frac{v_1}{v_2} = \frac{1}{2}}$

Q39 $\frac{hc}{\lambda} = \phi + eV$

$\frac{hc}{\lambda} - \phi = eV$

$\because$ V_1, V_2, V_3 are in AP

$\Rightarrow V_2 - V_1 = V_3 - V_2$

$\Rightarrow \left(\frac{hc}{\lambda_2} - \phi\right) - \left(\frac{hc}{\lambda_1} - \phi\right) = \left(\frac{hc}{\lambda_3} - \phi\right) - \left(\frac{hc}{\lambda_2} - \phi\right)$

$\Rightarrow \frac{1}{\lambda_2} - \frac{1}{\lambda_1} = \frac{1}{\lambda_3} - \frac{1}{\lambda_2}$

$\Rightarrow$ HP

Q40 $E = \phi + KE_{max}$

$5ev = \phi + 2ev$

$\Rightarrow \phi = 3ev$

$\Rightarrow E' = \phi^* + eV_s$

$\Rightarrow 6ev = 3ev + eV_s$

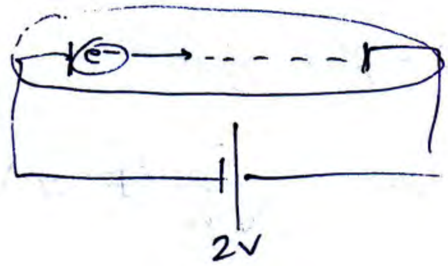
$\Rightarrow \cancel{V_s = 3e}$ $\boxed{V_s = 3V}$

$\Rightarrow$ anode voltage must be $-3V$ wrt cathode

Q41: $E = \phi + KE_{max}$

$\frac{hc}{\lambda} = \phi + KE_{max}$

$\lambda \to 200\,nm$, $\phi \to 4.5\,ev$



$\Rightarrow KE_{max} = 1.7\,ev$

$0 \leq KE \leq 1.7ev$

KE at collection $= KE + eV$

$= KE + e \times 2V$

$\Rightarrow \boxed{2 \leq KE \text{ at collection} \leq 3.7ev}$

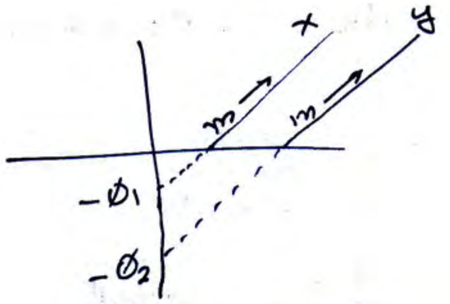
On reversing the polarity ; no electron will reach anode

Q42: Only photocurrent (i.e: no of electrons emitted) is effected

Q43 $hf = \phi + eV$

$\Rightarrow \underbrace{V}_{y} = \underbrace{\left(\frac{h}{e}\right)}_{m} \underbrace{f}_{x} - \phi$

$\Rightarrow \boxed{y = mx - \phi}$

$\Rightarrow$ 

Q44 Since the intensity is constant & energy of each photon is increased, the no. of photons decreases

$\Rightarrow$ Current decreases

Q45 $\frac{1}{4\pi\epsilon_0} \frac{q \cdot 3q}{r^2} = \frac{mv^2}{r}$

$\Rightarrow r = \frac{3q^2}{4\pi\epsilon_0 m v^2}$

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

$\cancel{m} \cdot \cancel{v} \cdot \frac{3q^2}{4\pi\epsilon_0 \cancel{m} v^2} = \frac{nh}{2\pi}$

$\Rightarrow$ for nearest : $n = 1$

$\Rightarrow \boxed{v = \frac{3q^2}{2\epsilon_0 h}}$

46> $mvr = \dfrac{nh}{2\pi}$

$\Rightarrow \boxed{J_n = \text{const} \times n}$

$v = \dfrac{Ze^2}{2\epsilon_0 nh}$

$\Rightarrow \boxed{v = \dfrac{\text{Const}}{n}}$

$\lambda_n = \dfrac{h}{p}$

$\Rightarrow \lambda_n = \dfrac{h}{mv}$

$\Rightarrow \boxed{\lambda_n = \dfrac{\text{Const}}{v}}$

$\Rightarrow \boxed{\lambda_n = \text{Const} \times n}$

$\Rightarrow \boxed{\lambda_n \propto J_n}$

47> $L = \dfrac{3h}{2\pi} \Rightarrow 3^{rd}$ orbit

$\mathcal{E}_{3rd} = -1.5\ eV$ & $KE = -\mathcal{E}$

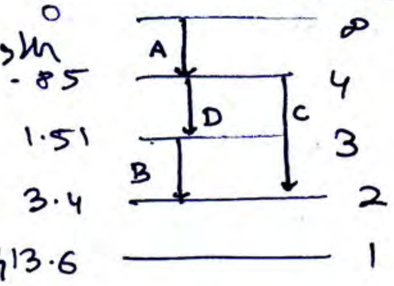
$\Rightarrow KE = 1.5\ eV$

~~48> A → longest ∵ shortest energy gap~~

~~C → Shortest ∵ longest~~ energy gap

48> D → longest wavelength
∵ smallest gap of energy

C → shortest wavelength
∵ Biggest energy gap



49> $f = \frac{v}{2\pi r}$ $\qquad v = \frac{ze^2}{2\epsilon_0 nh}$

$r = \frac{\epsilon_0 n^2 h^2}{\pi m z e^2}$

$= \frac{m z^2 e^4}{4\epsilon_0^2 n^3 h^3}$

$= \left(\frac{m z^2 e^4}{8\epsilon_0^2 n^2 h^2}\right) \frac{2}{nh}$

$= \frac{2E_n}{nh}$

50> ~~E~~ Ionization Energy $= 2.18 \times 10^{-18}$ J

Energy in 3^{rd} orbit $= \frac{1}{9}$th of Energy of 1^{st} orbit

$\Rightarrow$ Ionization from that level, Energy required

$= \frac{1}{9} \times 2.18 \times 10^{-18}$ J

$= 2.42 \times 10^{-19}$ J

51> $E_{4n} - E_{2n} = -13.6 z^2 \left(\frac{1}{(4n)^2} - \frac{1}{(2n)^2}\right)$

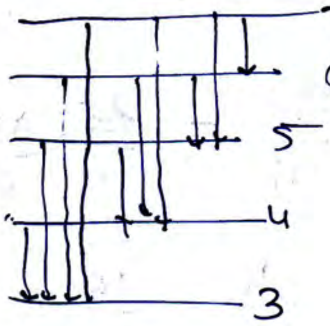
$E_{2n} - E_n = -13.6 z^2 \left(\frac{1}{(2n)^2} - \frac{1}{n^2}\right)$

Taking ratio : $z^0 n^0$

52> 2^{nd} excited state $\Rightarrow n = 3$

~~Son~~ So $n = 7$

$\Rightarrow$ 6^{th} excited state



53> $r = 0.53 \frac{n^2}{Z}$ Å

$\Rightarrow r \propto n^2$

$\Rightarrow (n+1)^2 - n^2 = (n-1)^2$

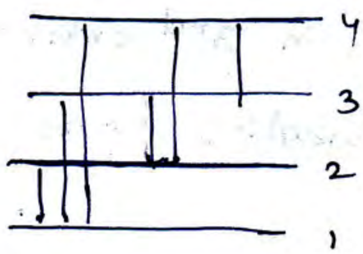
$\cancel{n^2} + \cancel{1} + 2n - \cancel{n^2} = n^2 + \cancel{1} - 2n$

$\Rightarrow \boxed{n = 4}$

54> 6 different wavelength

$\Rightarrow n_2 = 4$

So if Energy of emitted photon can be greater, less or equal to absorbed photon n_1 can only be 2



55> $M \rightarrow L \Rightarrow 3 \rightarrow 2$

$r \propto n^2$

$\Rightarrow \boxed{\frac{r_f}{r_i} = \frac{4}{9}}$

$\frac{kze^2}{r^2} = m a_c$

$\Rightarrow a_c \propto \frac{1}{r^2}$

$\Rightarrow \frac{a_f}{a_i} = \cancel{\frac{36}{16}} \frac{81}{16}$

$\Rightarrow \boxed{\frac{a_i}{a_f} = \frac{16}{81}}$

Q56 $f = \frac{v}{2\pi r}$; $v \propto \frac{1}{n}$, $r \propto n^2$

$\Rightarrow f \propto \frac{1}{n^3}$

$\Rightarrow \frac{f_1}{f_2} = \frac{n_2^3}{n_1^3}$

$\Rightarrow \frac{1}{27} = \frac{n_2^3}{n_1^3}$

$\Rightarrow \frac{n_1}{n_2} = 3$

Q57 $r \propto n^2$

$\Rightarrow \frac{r_n}{r_1} = \frac{n^2}{1^2}$

$\Rightarrow \frac{r_n}{a_0} = n^2$

$\Rightarrow r_n = n^2 a_0$

Q58 $E_{2nd} = -\frac{13.6 \times 1^2}{2^2}$ $\because E_{n^{th}} = -\frac{13.6\, z^2}{n^2}$

$\Rightarrow E_{2nd} = -3.4\,eV$

$\Rightarrow$ Energy required $= 3.4\,eV$

Q59 $r = \frac{\epsilon_0 n^2 h^2}{\pi m z e^2}$ for K shell $n = 1$

$\Rightarrow \frac{r_e}{r_\mu} = \frac{m_\mu}{m_e}$ $\Rightarrow r_\mu = \frac{m_e}{m_\mu} \times r_e$ $\hookrightarrow .53\,\mathring{A}$

$r_\mu = \frac{1}{207} \times .53\,\mathring{A} = 2.56 \times 10^{-3}\,\mathring{A}$

Q 60 → 10 different wavelength means the excitation was to $n = 5$

$$\Rightarrow \frac{1}{\lambda} = R\left(1 - \frac{1}{5^2}\right)$$

$$\Rightarrow \boxed{\lambda = 95nm}$$

Q61 → $E = +13.6\left(1 - \frac{1}{25}\right)$ eV

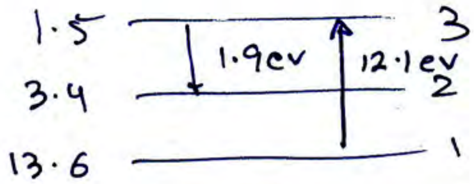
$$p = \frac{E}{c} = \frac{\left(13.6 \times \frac{24}{25} \times 1.6 \times 10^{-19}\right)}{3 \times 10^{8}} \approx 6.96 \times 10^{-27}$$

Same will be the momentum of hydrogen

$$\Rightarrow mv = 6.96 \times 10^{-27}$$

$$\Rightarrow v = \frac{6.96 \times 10^{-27}}{1.672 \times 10^{-27}} = 4.2 m/s$$

Q62



~~So Answer is 1.9ev~~

So to emit 1st Line of balmer, the electron had to be excited to $n = 3$ which requires 12.1 ev energy

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Q 63 $f = \frac{v}{2\pi r}$ $\quad v \propto \frac{1}{n}$, $r \propto n^2$

$$\Rightarrow f \propto \frac{1}{n^3}$$

$$\Rightarrow \frac{f_n}{f_1} = \frac{1^3}{n^3}$$

$$\Rightarrow \underbrace{\ln\left(\frac{f_n}{f_1}\right)}_{y} = -3\underbrace{(\ln n)}_{x} \rightarrow \boxed{y = -3x}$$

Q64 $\quad \frac{1}{\lambda} = RZ^2\left(\frac{1}{1^2} - \frac{1}{2^2}\right)$

$\Rightarrow \quad \lambda \propto \frac{1}{Z^2}$

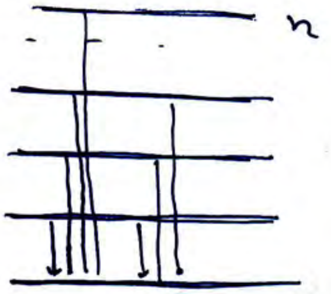
So Least λ will be for doubly ionized Lithium

Q65 $\quad T^2 \propto R^3$

$$\frac{T_1^2}{T_2^2} = \frac{R^3}{(4R)^3}$$

$$\boxed{\frac{T_1}{T_2} = \frac{1}{8}}$$

Q66



So if $n = 2 \Rightarrow$ Lines $= 1$

if $n = 3 \rightarrow$ Lines $= 3 = 1+2$

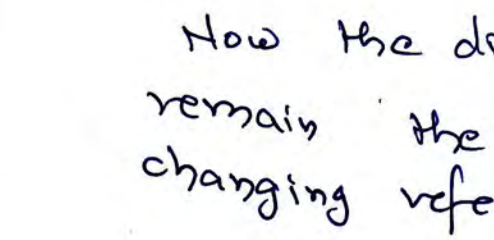
if $n = 4 \rightarrow$ lines $= 6 = 1+2+3$

⋮

if $n = n \rightarrow$ Lines $= 1+2+3+ \cdots n-1$

Q67

Old



New

$U = 0$

U_1

$\cancel{\Rightarrow -26}$

$-6.8 - (-27.2) = 0 - U_1$

$\Rightarrow U_1 = -20.4$

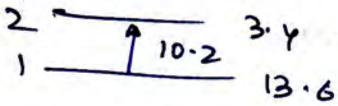
also $K_1 = 13.6$

$\Rightarrow E_1 = -20.4 + 13.6$

$= -6.8$

Now the differences remain the same even on changing reference

Q 68 The loss in KE $= \frac{K_0}{2}$



and a minimum loss of 10.2ev is required to cause excitation

So Neutron should have 20.4ev minimum to cause excitation

→ any lesser amount of initial KE will cause inelastic collision

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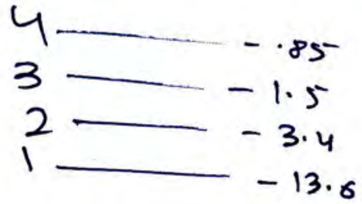
Q 69 $E = -K = \frac{U}{2}$



So as we go towards ground state the total energy becomes more Negative, hence it decreases

and from the formula we can see

If $E \downarrow \Rightarrow U \downarrow \Rightarrow K \uparrow$

Q 70

$r \propto n^2$

$f \propto \frac{1}{n^3}$ $\Rightarrow$ $frL \propto n^0$

$L \propto n$ $\Rightarrow$ constant for all orbits

Q 71 $\because$ K_B represents a larger energy gap hence it has lower wavelength

$\Rightarrow$ $K_B \rightarrow P$

$K_\alpha \rightarrow Q$

Q72 Energy difference is equal to the Energy of the K_α photon $= \frac{hc}{\lambda} = \frac{1242 \text{ ev-nm}}{.021}$

$= \cancel{59 \text{ ke}}$

$= 59 \text{ Kev}$

Q73 $X^{200} \longrightarrow A^{110} + B^{90}$

increase in BE = mass defect energy = energy released

$\Rightarrow \Delta BE = (110 \times 8.2 + 90 \times 8.2) - 7.4 \times 200$

$= 160 \text{ Mev}$

Q74 Energy required = Loss in BE $\quad C_{13} \longrightarrow C_{12} + n$

$= (BE)_{C_{13}} - (BE)_{C_{12}}$

$= (13 \times 7.5) - (12 \times 7.68)$

$= 5.34 \text{ Mev}$

Q75 $X \rightarrow BE = E_1$

$Y \rightarrow BE = E_2$

$2X \longrightarrow Y$

Energy released = increase in BE

$Q = E_2 - 2E_1$

Q76 $r = 0.53 \frac{n^2}{Z} \mathring{A}$ ($n \to 2$, $Z \to 2$)

$= 1.06 \mathring{A}$

Q77 $E = -3.4 \text{ ev} \Longrightarrow n = 2$

$\Rightarrow L = \frac{nh}{2\pi}$ ($n = 2$) $\Rightarrow \boxed{L = \frac{h}{\pi}}$

Q 78 no of fissions required per second = $\frac{\text{Power required}}{\text{Energy released per fission}}$

$$= \frac{1\,kW}{200\ MeV}$$

$$= \frac{1000}{200 \times 10^{6} \times 1.6 \times 10^{-19}}$$

$$= 3.125 \times 10^{13}$$

Q 79 $^{2}_{1}H \rightarrow 1876\ MeV$

$n \rightarrow 940\ MeV$ $n + p = 1879\ MeV$

$p \rightarrow 939\ MeV$

$\therefore$ so for fission an extra 3 MeV is required which can be obtained by absorbing a γ photon of 3 MeV Energy

---

~~Q 80~~

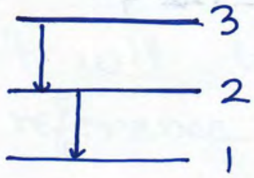
Exercise II

Q1: $hf = \phi + eV$

$\Rightarrow \quad V = \left(\frac{h}{e}\right)f - \phi$

So V depends on f & ϕ $\rightarrow$ emitter's properties

Q2



$\frac{1}{\lambda_1} = R\left(\frac{1}{4} - \frac{1}{9}\right)$

$\Rightarrow \boxed{\lambda_1 = \frac{36}{5R}}$

$\frac{1}{\lambda_2} = R\left(1 - \frac{1}{4}\right)$

$\Rightarrow \boxed{\lambda_2 = \frac{4}{3R}}$

$x = \frac{\lambda_1}{\lambda_2} = \frac{\frac{36}{5R}}{\left(\frac{4}{3R}\right)} = \frac{27}{5}$

$y = \frac{p_1}{p_2} = \frac{h/\lambda_1}{h/\lambda_2} = \frac{\lambda_2}{\lambda_1} = \frac{5}{27}$

$z = \frac{E_1}{E_2} = \frac{\frac{hc}{\lambda_1}}{hc/\lambda_2} = \frac{\lambda_2}{\lambda_1} = \frac{5}{27}$

$\Rightarrow z = 1/x$

Q3 $K = -E = 3.4\,eV$ $\qquad \lambda = \frac{h}{p} = \frac{h}{\sqrt{2mK}}$

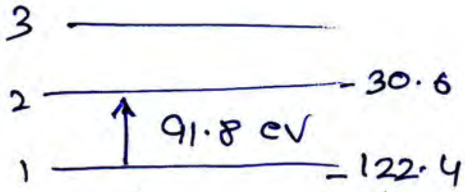
$\lambda = \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 3.4 \times 1.6 \times 10^{-19}}}$

$= 6.66 \times 10^{-10}$

Q4

$$E = \frac{13.6\, z^2}{n^2} \Rightarrow 122.4 = \frac{13.6\, z^2}{1^2}$$

$$\Rightarrow \boxed{z = 3}$$

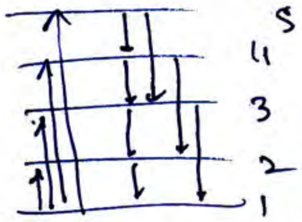


→ To cause even a single jump an energy of 91.8 eV is required
So 90 eV is not sufficient

→ So if an electron of 91.8 eV KE can provide full of its KE to cause excitation & itself it can come to rest

→ if electron of KE 125 eV collides with an atom it can cause ionization with an ejected electron having energy $125 - 122.4 = 2.6$ eV

Q5 ultraviolet light lies in the ~~balmer~~ lyman series and it can cause excitation from $n=1$ to higher orbits



but in deexcitation we can have a stepwise deexcitation which can release othere wavelengths including ultraviolet and visible ~~too~~ & infrared too

---

Q6 $\because$ Hydrogen is in ground state $\Rightarrow n=1$

$\Rightarrow$ the absorption can only be in lyman series

Q7 Changing the reference does not affect the differences in energy of two levels

& since the energy of upper shells is higher

$\rightarrow$ it will be higher even with the new reference

@ ground state $U = 0$, $K = 13.6\,eV$

$\Rightarrow E = 13.6\,eV$

Q8> if we consider motion of nucleus we have to consider reduced mass instead of mass of electron

$$\mu = \frac{m_N m_e}{m_N + m_e}$$

$$\Rightarrow \mu = \frac{m_e}{1 + \left(\frac{m_e}{m_n}\right)}$$

$\Rightarrow$ the one with heavier nucleus will have higher reduced mass

$\because$ $r \propto \frac{1}{\mu}$ $\Rightarrow$ $r_{Hydrogen} > r_{deuterium}$

$\because$ velocity is independent of mass, it does not matter

$\because$ $E \propto m$ $\Rightarrow$ Energy differences are more in deuterium $\Rightarrow$ wavelengths would be lesser in case of deuterium

$\because$ $L = \frac{nh}{2\pi}$ $\Rightarrow$ 1st orbit $L = \frac{h}{2\pi}$ same for both

Q9 $\quad r \propto n^2$

$A \propto r^2$

$\Rightarrow A \propto n^4$

$\Rightarrow \dfrac{A_n}{A_1} = \cancel{\dfrac{r_n^4}{r_1^4}} \quad \dfrac{n^4}{1^4}$

$\Rightarrow \left(\dfrac{A_n}{A_1}\right) = n^4$

$\Rightarrow \ln\left(\dfrac{A_n}{A_1}\right) = 4\ln n$

$\Rightarrow \boxed{y = 4x}$

Q10

maximum possible loss in KE $= \frac{1}{2}mv_0^2 - \frac{1}{2}2m\left(\frac{v_0}{2}\right)^2$

$= \frac{1}{4}mv_0^2$

$= \frac{K_0}{2}$

1st excitation Energy of Hydrogen $= 13.6 - 3.4$

$= 10.2$

So the loss must atleast be that much to cause excitation $\Rightarrow \frac{K_0}{2} \geq 10.2$

$\Rightarrow K_0 \geq 20.4$

So if $K_0 < 20.4 \rightarrow$ No excitation $\rightarrow$ elastic collision

if $K_0 = 20.4 \rightarrow$ Total loss $\rightarrow$ perfectly inelastic

if $K_0 > 20.4 \rightarrow$ Some loss $\rightarrow$ inelastic

---

Q11 α decay $\rightarrow$ loss of 2 protons, 2 neutrons

$\rightarrow$ Z, A both decrease

β^- decay $\rightarrow$ converts neutron to proton

$\Rightarrow$ Z inc, A $\rightarrow$ same

β^+ decay $\rightarrow$ Converts proton to neutron

$\Rightarrow$ Z dec, A $\rightarrow$ same

γ decay $\rightarrow$ only energy

Z $\rightarrow$ same, A $\rightarrow$ same

---

12 > $\lambda_{min} = \frac{hc}{eV} \Rightarrow V = \frac{hc}{e\lambda_{min}}$

$\Rightarrow$ ~~$V = \frac{hc}{e\lambda}$~~

$$= \frac{6.63\times10^{-34} \times 3\times10^{8}}{1.6\times10^{-19} \times 66.3\times10^{-12}}$$

$= 18750$ V

$= 18.75$ kV

$$\lambda_{de\ broglie} = \frac{h}{p}$$

$$= \cancel{\frac{h}{(E/c)}} \quad \frac{h}{\sqrt{2m(KE)}}$$

$\rightarrow$ eV

$$= \frac{6.63\times10^{-34}}{\sqrt{2\times 9.1\times10^{-31} \times 1.6\times10^{-19} \times 18750}}$$

$= 8.97\times10^{-12} \approx .08$ Å

Q13: Since more energetic photons are emitted now
$\Rightarrow$ The total Energy increases $\Rightarrow$ Intensity increases

also $\lambda_{min} = \frac{hc}{eV}$ $\Rightarrow$ $V\uparrow \Rightarrow \lambda\downarrow$

Q14 initially nucleus has equal no of proton & neutrons
→ in heavier elements no of neutrons is more

→ neutron – proton ratio continuously increases

→ 

BE per nucleon increases & then decreases

Q15

$$BE_{Ne} = (10m_p + 10m_n - M_1)c^2$$

$$BE_{Ca} = (20m_p + 20m_n - M_2)c^2$$

$$\Rightarrow M_1 = 10(m_p + m_n) - \frac{BE_{Ne}}{c^2}$$

$$\Rightarrow \boxed{M_1 < 10(m_p + m_n)}$$

also $\cancel{2M_2}$ $M_2 - 2M_1 = \frac{1}{c^2}\left(2BE_{Ne} - BE_{Ca}\right)$

$BE_{Ne} \to 20\times\left(\frac{BE}{A}\right)_{Ne}$

$BE_{Ca} \to 20\times\left(\frac{BE}{A}\right)_{Ca}$

$$= \frac{40}{c^2}\left(\underbrace{\left(\frac{BE}{A}\right)_{Ne} - \left(\frac{BE}{A}\right)_{Ca}}_{<0}\right)$$

$$\Rightarrow M_2 - 2M_1 < 0$$

$$\Rightarrow \boxed{M_2 < 2M_1}$$

Q16 A> $\lambda = 0.173$ years

decayed part $N_{decayed} = N_0(1-e^{-\lambda t})$

$$\cdot 63\, N_0 = N_0(1-e^{-\lambda t})$$

$$\Rightarrow e^{-\lambda t} = \cdot 37$$

$$\Rightarrow e^{-\lambda t} = 1/e$$

$$\Rightarrow -\lambda t = -1$$

$$\Rightarrow t = \frac{1}{\lambda} = \frac{1}{\cdot 173} \text{ years}$$

B> half Life $= \frac{\cdot 693}{\lambda} = \frac{0.693}{\cdot 173}$

C> $N = N_0 e^{-\lambda t}$

$\cancel{\frac{3}{4} N_0} = N_0 e^{-\lambda t}$ $\Rightarrow$ $N = N_0 e^{-(\cdot 173 \times 8)}$

$\Rightarrow \cancel{\lambda t = \ln \frac{4}{3}}$ $\boxed{N = \cdot 25\, N_0}$

$\Rightarrow \cancel{t = \frac{\ln 4/3}{\lambda}}$

---

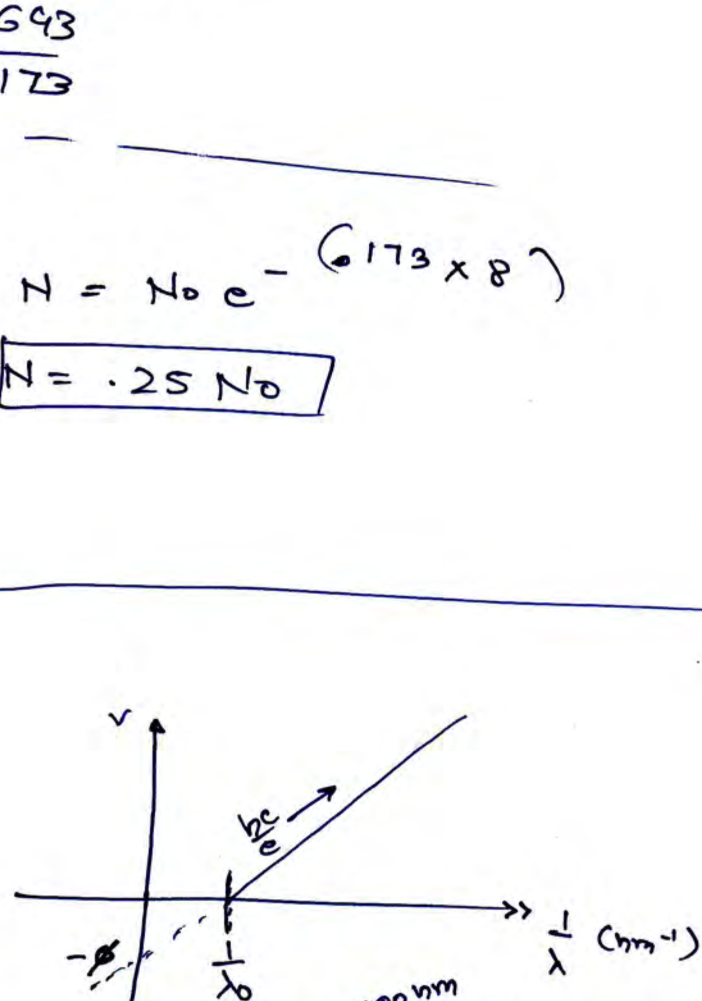
(17) $\cancel{\frac{hc}{\lambda} = \phi \frac{hc}{\lambda_0}}$

$$\frac{hc}{\lambda} = \phi + eV_s$$

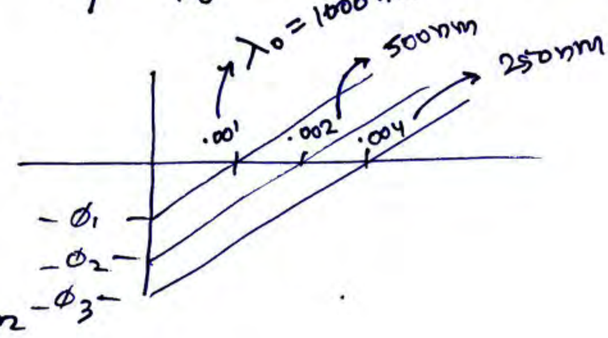
$$\Rightarrow V_s = \frac{hc}{e\lambda} - \phi$$

$$\Rightarrow y = \underbrace{\left(\frac{hc}{e}\right)}_{\text{slope}} x - \phi$$

$$\Rightarrow \boxed{\phi_1 : \phi_2 : \phi_3 = 1:2:4}$$



$\Rightarrow$



ultraviolet can eject from metal (1) & (2) $\because \lambda_{ultraviolet} < 400$nm

Exercise 3

Comprehension - 1

1> Since mass is not conserved, we cannot find the mass of that particle but still it is possible to find the total Energy of that particle since total energy is conserved

$$E_{3rd\ particle} = E_{neutron} - E_{proton} - E_{electron}$$

$$= (940.97) - (939.67 + .01) - (0.51 + 0.39)$$

$$= \cancel{0.39}\ 0.39 \text{ Mev}$$

→ This is the total Energy but we cannot be sure how much of it is in the form of mass energy. hence "d"

2> "a" discussed in previous part

3>
$$\underbrace{TE}_{y} = \underbrace{KE}_{constant = K} + \underbrace{m}_{constant = m}\underbrace{c^2}_{x}$$

$\Rightarrow$ $y = mx + c$ hence "c"

4> An isolated proton can never decay into a neutron since a neutron is heavier, hence it would be against energy conservation principles for such a reaction to occur, However if the proton posesses extra potential energy from its interactions with other particles in the nucleus, such a reaction would be feasable, infact it does happen in nature.

~~Ex~~ Comprehension 2

5> Q value = Total increase in the BE of system

$= BE_f - BE_i$

$= (E_2N_2 + E_3N_3) - E_1N_1$ Hence "b"

6> The Nuclei with higher BE per nucleon also have a lower mass per nucleon.

$\Rightarrow$ ~~lower~~ higher BE per nucleon $\Rightarrow$ lower mass per nucle

$\Rightarrow \frac{M_w}{N_1} > \frac{M_y}{N_2} > \frac{M_x}{N_3}$

7> Even though the BE per nucleon decreases for nuclei heavier than Z, but the total no of nucleons ~~is~~ also increases

$TBE = \underbrace{(BE \text{ per Nucleon})}_{\text{decreasing}} \times \underbrace{(\text{No of nucleons})}_{\text{increasing}}$

hence it is observed that TBE increases but the relation of TBE vs Atomic mass No is Not linear infact its slope decreases on increasing atomic mass implying that very heavy nuclei become increasingly instable since the TBE isnt increasing sufficiently.

Comprehension 3

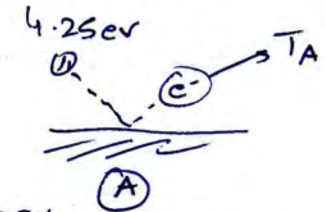
8> $${}^{1}_{1}p \xrightarrow{\beta^+ \text{ decay}} {}^{1}_{0}n + {}^{0}_{1}e + {}^{0}_{0}\nu$$

So answer is B

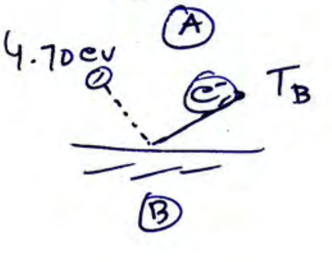
9> in β^- decay the atomic No rises by 1
So two successive β^- decay $\Rightarrow$ atomic No rises by 2
hence answer is C

10> the net momentum has to be zero which is not possible in case of just one photon, hence answer is C

Match the columns

1> 

$$4.25 = \phi_A + T_A$$



$$4.70 = \phi_B + T_B$$

also $\lambda_B = 2\lambda_A$

$\Rightarrow \dfrac{h}{p_1} = 2\dfrac{h}{p_2}$

$\Rightarrow p_2 = 2p_1$

$\Rightarrow \sqrt{2mKE_1} = 2\sqrt{2mKE_2}$

$KE_1 = 4KE_2$

$T_A = 4T_B$

$T_A = 4(T_A - 1.5)$

$\Rightarrow \boxed{T_A = 2\text{ev}}$

$\Rightarrow \boxed{\phi_A = 2.25\text{ev}}$

$\boxed{T_B = 0.5\text{ev}}$

$\Rightarrow \boxed{\phi_B = 4.20\text{ev}}$

2> $T^2 \propto r^3$ and $r \propto n^2$

$\Rightarrow T^2 \propto n^6$

$\Rightarrow T \propto n^3$

$\Rightarrow \frac{T_1}{T_2} = \frac{n_1^3}{n_2^3}$

$\Rightarrow \cancel{\frac{T_1}{8T_1} = \frac{n_1^3}{n_2^3}} \Rightarrow \cancel{n_2^3 = 8n_1^3}$

$\Rightarrow \cancel{n_2 = 2n_1}$

$\frac{8T_2}{T_2} = \frac{n_1^3}{n_2^3} \Rightarrow \boxed{n_1 = 2n_2}$

$\Rightarrow (n_1, n_2)$ can be $(4,2)$ or $(6,3)$

3> Theory Based

4> Theory Based

5> Theory Based

6> Theory Based

Exercise 4

Q1> a> $\frac{hc}{\lambda} = \phi + eV_s$

$\lambda \to 4950\,\mathring{A}$, $\phi \to ?$, $V_s \to 0.6\,V$

$\Rightarrow \phi = 1.9\,eV$

b> $\frac{hc}{\lambda'} = \phi + eV_s'$

$\lambda' \to ?$, $\phi \to 1.9\,eV$, $V_s' \to 1.1\,V$

$\Rightarrow \lambda' = 4125\,\mathring{A}$

c> No change since magnetic field does not affect KE

Q2

i> $P = \frac{dn}{dt} \times E_0$

$E_0 \to$ Energy of each photon

$\frac{dn}{dt} \to$ No of photons emitted per second

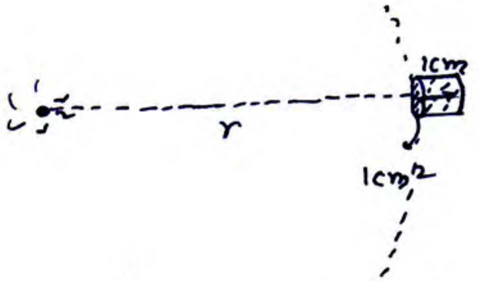
$\frac{dn}{dt} = \frac{(100\,W)}{\frac{hc}{\lambda}} = 3\times10^{20}$ photons/sec

$\lambda \to 5890\,\mathring{A}$

ii> Photon flux $= \frac{\left(\frac{dn}{dt}\right)}{4\pi r^2} = 1\,\frac{\text{photon}}{cm^2\,s}$

$$\frac{3\times10^{20}}{4\pi r^2} = 1$$

$\Rightarrow r = 4.9\times10^{4}$ km

iii) 

$$\text{density of photon} = I \times \frac{1\,cm}{c}$$

I → Photon intensity

c → speed of light

$$= \cancel{\frac{1\ photon}{cm^2\text{-}sec}}$$

$$1\ photon/cm^3 = \frac{3\times10^{20}}{4\pi r^2} \times \frac{1\,cm}{300\times10^8\,cm/s}$$

$$\Rightarrow \quad r = 282\,m$$

iv) $$\text{photon flux} = \frac{3\times10^{20}}{\cancel{4\pi\times(20)}\ 4\pi\times(200)^2} = 5.96\times10^{14}\ photon/cm^2$$

$$\text{photon density} = \text{photon flux} \times \frac{1\,cm}{c}$$

$$= 5.96\times10^{14} \times \frac{1}{300\times10^8}$$

$$= 20\times10^3\ photons/cm^3$$

Q3

$$\Delta E = 13.6\, z^2 \left(1 - \frac{1}{2^2}\right) \text{ ev}$$

$$= 13.6 \times \cancel{3} \text{ ev}$$

So $\Delta E = \underbrace{\text{ionization Energy}}_{\text{Hydrogen}} + KE$

$$13.6 \times 3 = 13.6 + KE$$

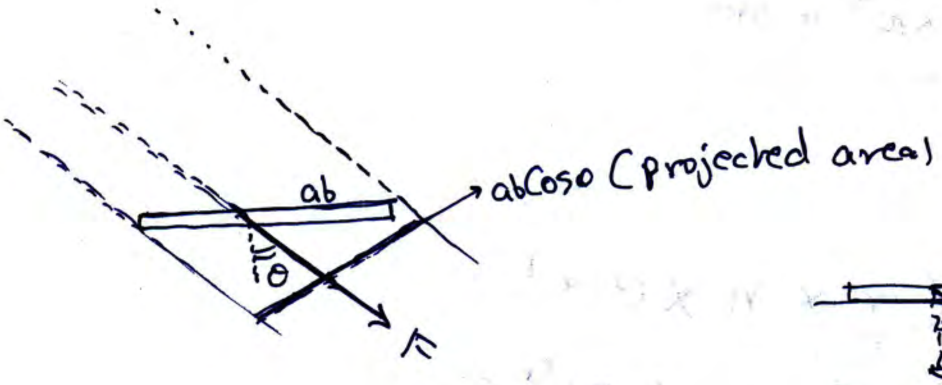
$$KE = 27.2\,\text{ev}$$

$$\Rightarrow \frac{1}{2} m v^2 = 27.2\,\text{ev}$$

$$\Rightarrow \frac{1}{2} \times 9.1 \times 10^{-31} = 27.2 \times \cancel{10^{-31}}\ 1.6 \times 10^{-19}$$

$$\Rightarrow \boxed{v = 3.1 \times 10^{6}\ \text{m/s}}$$

Q4



$$\text{force} = \frac{I}{c} \times \text{projected area}$$

$$= \frac{I}{c} \times ab\cos\theta$$

$$a = \frac{F\sin\theta - \mu N}{m}$$

$$N = mg + F\cos\theta$$

Q5 : $\frac{3}{2}KT = \frac{1}{2}mv^2$

$\Rightarrow \quad 3KT = \frac{(mv)^2}{m}$

$\Rightarrow \quad p = \sqrt{3mKT}$

$\Rightarrow \quad \lambda = \frac{h}{p} = \frac{h}{\sqrt{3mKT}}$

$h = 6.625 \times 10^{-34}$
$m = 1.66 \times 10^{-27}$
$K = 1.38 \times 10^{-23}$
$T = 400K$

Q6 : $T_{1/2} = 5568$ years

$A = A_0 e^{-\lambda t}$

$\frac{A}{A_0} = e^{-\lambda t}$

$\Rightarrow \quad \frac{3.9}{15.6} = e^{-\frac{\ln 2}{T_{1/2}} \times t}$

$\Rightarrow \quad t = 1.118 \times 10^4$ years

Q7 $\quad V = \frac{kQ}{r}$

$V = \frac{k}{r}(r \times \eta \times e \times t)$

rate efficiency

$2 = \frac{9 \times 10^9}{10^{-2}} (5 \times 10^{10} \times .4 \times 1.6 \times 10^{-19} \times t)$

$\Rightarrow t = 6.9 \times 10^{-4}$ sec

Q8 $\sqrt{f} = a(z-b)$

$$\Rightarrow \sqrt{\frac{c}{\lambda}} = a(z-b)$$

$$\Rightarrow \sqrt{\frac{\overset{887}{\lambda_{AL}}}{\underset{146}{\lambda_{zn}}}} = \frac{(\overset{30}{Z_{zn}} - b)}{(\underset{13}{Z_{AL}} - b)}$$

$$\Rightarrow \boxed{b = 1.4}$$

$$\sqrt{\frac{\lambda_{Fe}}{\underset{887}{\lambda_{AL}}}} = \frac{(\overset{13}{Z_{AL}} - \overset{1.4}{b})}{(\underset{26}{Z_{Fe}} - b)}$$

$$\Rightarrow \lambda_{Fe} = 198 \text{ pm}$$

Q9 $\sqrt{\underset{4.2\times10^{18}}{f}} = \overset{\sqrt{\frac{3RC}{4}}}{a}\,(z-\underset{1}{b})$

$R = 1.1\times10^{7}$

$C = 3\times10^{8}$

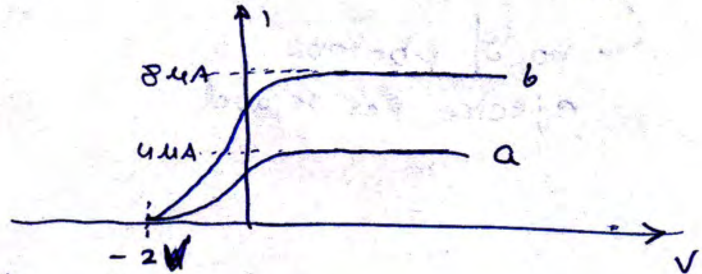
$$\Rightarrow z = 42$$

Exercise ~~IV~~ 5

1> $E = \phi + KE_{max}$

$\Rightarrow 5eV = 3eV + eV_s$

$\Rightarrow \boxed{V_s = 2V}$



and on doubling intensity the saturation current also doubles

---

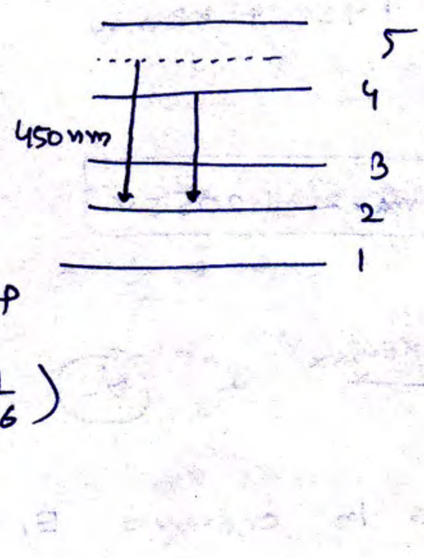
2> $\frac{1}{\lambda} = RZ^2\left(\frac{1}{m^2} - \frac{1}{n^2}\right)$

$\frac{1}{450 \times 10^{-9}} = 1.09 \times 10^7 \times 1^2 \left(\frac{1}{2^2} - \frac{1}{n^2}\right)$

$\Rightarrow \boxed{n = 4.65}$

So exact 450 nm will be emitted from a transition from 4.65 → 2 quantum no. (which is not possible)

So the closest wavelength to 450 nm & between (450 & 700) will be from 4 → 2 quantum jump



ie $E = 13.6\left(\frac{1}{4} - \frac{1}{16}\right)$

$\boxed{E = 2.55\ eV}$

$\Rightarrow E = \phi + KE_{max}$

$\Rightarrow 2.55 = 2 + KE_{max}$

$\Rightarrow \boxed{KE_{max} = .55\ eV}$

37 $\dfrac{dn}{dt} = \dfrac{IA}{E_0} \times \eta$

↳ no of photons ejected per second

I = Intensity
A = incident area
E_0 = Energy of a photon
η = efficiency of ejection

$\Rightarrow \dfrac{dn}{dt} = \left(\dfrac{2 \times 1\times10^{-4}}{10.6 \times 1.6\times10^{-19}}\right) \times \dfrac{.53}{100} = 6.25 \times 10^{11}$

also $KE_{max} = E - \phi$
$= 10.6 - 5.6$
$= 5eV$

$0 \leq KE \leq KE_{max}$

$\Rightarrow 0 \leq KE \leq 5eV$

---

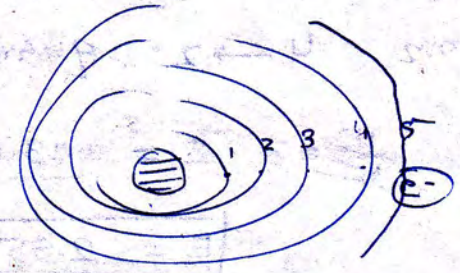
47 On photoelectron emmission

$E = \phi + KE_{max}$

$\dfrac{hc}{\lambda} = 1.9eV + KE_{max}$

$h = 4.14\times10^{-15}$ eVs
$C = 3\times10^{8}$ m/s
$\lambda = 400nm$

$\Rightarrow \boxed{KE_{max} = 1.205eV}$

e- $\xrightarrow{KE_{max}}$ + α ⟶ 

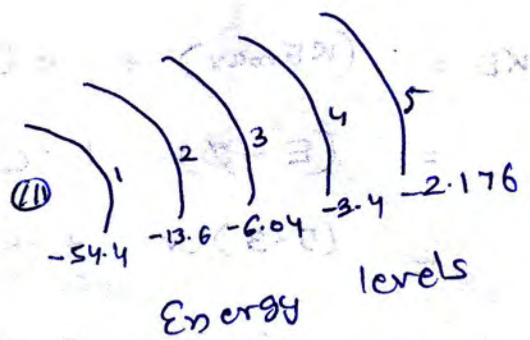
Loss in energy = $E_i - E_f$

$= 1.205 - \left(-13.6 \times \dfrac{z^2}{n^2}\right)$ ($z \to 2$, $n \to 5$)

$= 3.381$ eV

So a photon of Energy $\boxed{3.381}$ eV is emitted

So now photons will be emitted due to deexcitation



between 2ev & 4ev will be due to

$5 \rightarrow 3$: $= 6.04 - 2.176 = \boxed{3.864\ ev}$

$4 \rightarrow 3$: $= 6.04 - 3.4 = \boxed{2.64\ eV}$

Q5 $n = 10^{16}$ photons per metre square per second

$\Rightarrow$ $n \times A$ photons per second

$\Rightarrow$ no of ~~e~~ electrons ejected $= nA \times x$ per sec

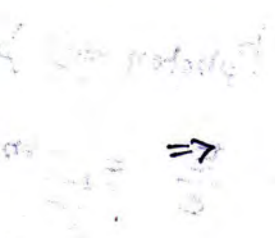
where $x = \frac{1}{10^6}$

$\Rightarrow$ no of electrons ejected in 10 sec $= nAx \times 10$

$$N_0 = 10^{16} \times 5 \times 10^{-4} \times \frac{1}{10^6} \times 10$$

$$\boxed{N_0 = 5 \times 10^7}$$

$Q = 33.7 \times 10^{-12}$



charge on the left side of right plate

$$q = \frac{Q}{2} \mp N_0 e$$

$$= \frac{33.7 \times 10^{-12}}{2} \mp 5 \times 10^7 \times 1.6 \times 10^{-19}$$

$$= 8.85 \times 10^{-12}\ C$$

$\Rightarrow$

$$E = \frac{(q/A)}{\epsilon_0} = \frac{\left(\frac{8.85 \times 10^{-12}}{5 \times 10^{-4}}\right)}{8.85 \times 10^{-12}} = \boxed{2000\ N/C}$$

$$KE = (KE_{max}) + e(Ed)$$
$$= (E - \phi) + e(2000 \times 10^{-2})$$
$$= (5-3)ev + e(20v)$$
$$= 3ev + 20ev$$
$$= 23\,ev$$

6> $E = -KE = \frac{U}{2}$

$\Rightarrow KE = -E$

$\Rightarrow KE = -(-3.4)$

$= 3.4ev$

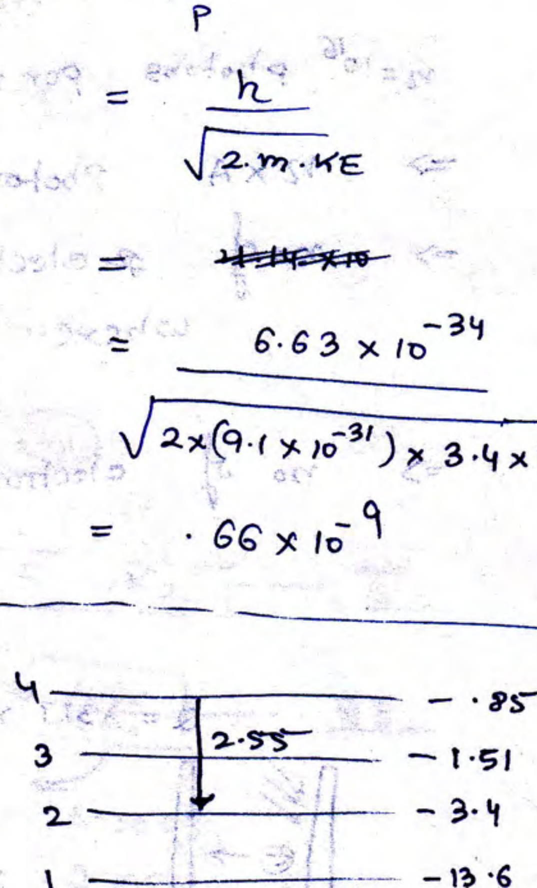
$$\lambda_{de\ broglie} = \frac{h}{p}$$
$$= \frac{h}{\sqrt{2 \cdot m \cdot KE}}$$
$$= \cancel{[illegible]}$$
$$= \frac{6.63 \times 10^{-34}}{\sqrt{2 \times (9.1 \times 10^{-31}) \times 3.4 \times 1.6 \times 10^{-19}}}$$
$$= .66 \times 10^{-9}$$

7> a> $E = \phi + KE_{max}$

$= 1.82 + .73$

$= 2.55\ ev$

b>



So $4 \rightarrow 2$

c> $L_i = 4\left(\frac{h}{2\pi}\right)$

$L_f = 2\left(\frac{h}{2\pi}\right)$

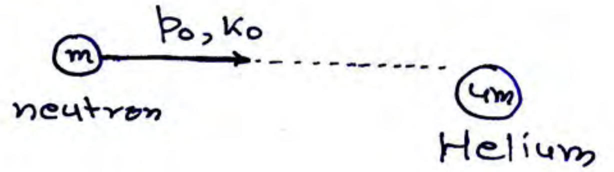
$|\Delta L| = \frac{2 \cdot h}{2\pi} = \frac{h}{\pi}$

d> $p_{photon} = p_{hydrogen\ atom}$

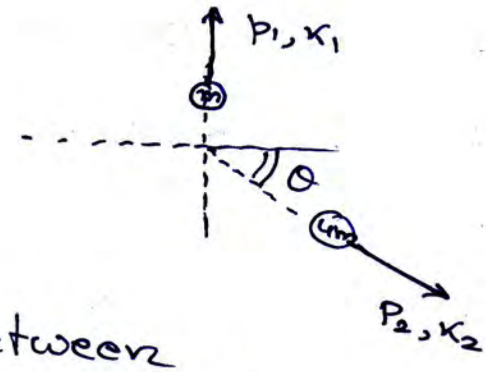
$\frac{E}{c} = mv$

$v = \frac{E}{mc} = \frac{2.55 \times (10^{-19} \times 1.6)}{(1.672 \times 10^{-27}) \times (3 \times 10^{8}}$

Q.8



$\Longrightarrow$



$p = \sqrt{2mK}$ (relation between momentum & KE)

Conservation of momentum

$\underline{\underline{x}}$ $\quad p_0 = p_2 \cos\theta$

$\Rightarrow \sqrt{2mK_0} = \sqrt{2(4m)K_2}\,\cos\theta$

$\Rightarrow \boxed{K_0 = 4K_2 \cos^2\theta} \longleftarrow (1)$

$\underline{y}$ $\quad p_1 = p_2 \sin\theta$

$\Rightarrow \sqrt{2mK_1} = \sqrt{2(4m)K_2}\,\sin\theta$

$\Rightarrow \boxed{K_1 = 4K_2 \sin^2\theta} \longleftarrow (11)$

$(1) + (11) \Longrightarrow \boxed{K_0 + K_1 = 4K_2} \text{ --- } \underline{\mathrm{I}}$

also $\boxed{K_0 = K_1 + K_2 + \underline{\Delta E}} \text{ --- } \underline{\mathrm{II}}$

Loss of Energy (which goes into exciting the electron)

Solving I & II

$K_1 = \dfrac{3K_0}{5} - \dfrac{4}{5}\Delta E$ $\qquad \Delta E = 13.6 \times 2^2 \left(1 - \dfrac{1}{n^2}\right)$

$K_2 = \dfrac{3K_0}{2} - \dfrac{\Delta E}{5}$

for $n=1$ (ie No excitation)

$K_1 = 39$, $K_2 = 26$

for $n=2$

$K_1 = 6.36$, $K_2 = 17.84$

for $n=3$

$K_1 = 0.312$, $K_2 = 16.328$

for $n=4$

$K_1 = -ve \longrightarrow$ Not possible

So at max the electron will be excited to $n=3$

So $h\nu = 13.6 \times 2^2 \left(\frac{1}{n^2} - \frac{1}{m^2} \right)$ eV

for $n=2, m=3$: $\nu = 1.82 \times 10^{15}$

for $n=1, m=3$: $\nu = 11.67 \times 10^{15}$

$n=1, m=2$: $\nu = 9.84 \times 10^{15}$

9> $T_{\frac{1}{2}} = 4.5 \times 10^9 = \frac{\ln 2}{\lambda}$

$U^{238} \longrightarrow Pb$

U^{238} No: $= N_0 e^{-\lambda t}$

Pb No: $= N_0 (1 - e^{-\lambda t})$

$\Rightarrow \frac{\text{No: } Pb}{\text{No: } U^{238}} = \frac{(1 - e^{-\lambda t})}{e^{-\lambda t}} = \frac{1 - e^{-\frac{\ln 2}{4.5 \times 10^9} \times 1.5 \times 10^9}}{e^{-\frac{\ln 2}{4.5 \times 10^9} \times 1.5 \times 10^9}}$

$= \frac{1 - e^{-\frac{\ln 2}{3}}}{e^{-\frac{\ln 2}{3}}}$

$= \frac{1 - 2^{-1/3}}{2^{-1/3}} = \frac{1 - \frac{1}{1.26}}{\frac{1}{1.26}}$

$= 0.26$

10 >

$KE = 0.327\ eV$ $\qquad T_{\frac{1}{2}} = 700\ sec$

$\frac{1}{2}mv^2 = 0.0327 \times 1.6 \times 10^{-19}\ J$

$\frac{1}{2} \times 1.675 \times 10^{-27} v^2 = .0327 \times 1.6 \times 10^{-19}$

$\Rightarrow \quad v = 0.25 \times 10^4$

$t = \frac{dist}{velocity} = \frac{10}{0.25 \times 10^4} = 4 \times 10^{-3}\ s$

fraction of Neutrons decayed $= 1 - e^{-\lambda t}$

$= 1 - e^{-\frac{.693}{700} \times 4 \times 10^{-3}}$

$= 3.96 \times 10^{-6}$

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11 >

$\sqrt{f} = a(Z-b)$ $\quad 1$

4.2×10^{18} $\qquad \sqrt{\frac{3RC}{4}}$: $R = 1.1 \times 10^7\ m^{-1}$; $C = 3 \times 10^8\ m/s$

$\Rightarrow \quad Z = 42$

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12 >

$r = R_0 A^{1/3}$

$\Rightarrow \frac{r}{r_{He}} = \left(\frac{A}{A_{He}}\right)^{1/3}$

$(14)^{1/3} = \left(\frac{Z+30}{4}\right)^{1/3}$

$\Rightarrow \boxed{Z = 26}$

$f = a(Z-b)^2$

$f = \frac{3RC}{4}(26-1)^2$

$R = 1.1 \times 10^7$

$C = 3 \times 10^8$

$\Rightarrow \boxed{f = 1.546 \times 10^{18}\ Hz}$