12/09/17

Atomic Structure

[*] J.J Thomson model:

J.J Thomson discovered $e^{\ominus}$s in each metal.

He suggested that structure of atom is just like a watermelon. Red part or flesh part of water melon represent +ve charge of metal and seeds are just like -ve charge therefore removal of $e^{\ominus}$ is easy as compared to removal of +ve charge.

[*] Failure & Limitation.

* Unable to Explain scatring of α particle when they are Bombarded on gold foil.

[*] Rutherford Model:

Rutherford Bombarded α Particle on a gold foil of thickness 10^{-8} m He observed that

(i) most of the α-particles passes throw Gold foil without deviation

(ii) One of the Particle out of the 20,000 Particle deviate by an angle of 180°

$a = \frac{v^2}{R}$

from these observation He Concluded that most of the space of atom is ~~a~~ ~~rd~~ empty.

And +ve charge is Concentrated at the Centre. $e^{\ominus}$ Revolves around nucleus

* Limitations :- :- Stability of e^-
All charge particle which are in accelerated Motion Radiates Energy in form of electro magnetic wave.

There fore energy of orbiting $e^{\ominus}$ decreases Continuously and $e^{\ominus}$ must fall on the nucleus throw spiral path.

(2) Unable to explain spectrum obtain in the emittion of Radiation from the gas atom.

Acc. to Rutherford $e^{\ominus}$ must emitt energy Continuously There fore initian and spectrom of atom must be Continuous.

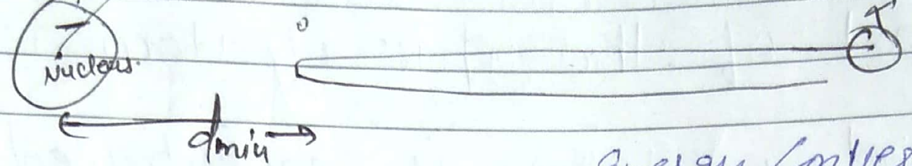
While it was observed that spectrum ~~observed~~ obtain was decreates.

Gold
Silver
Meallidbler

$k = 9 \times 10^9$
z = At no. of Gold Nucleus
e - $e^{\ominus}$ic Charge

Q.1

A gold foil.



$$\Delta U = -W_{EF} = q\Delta V$$

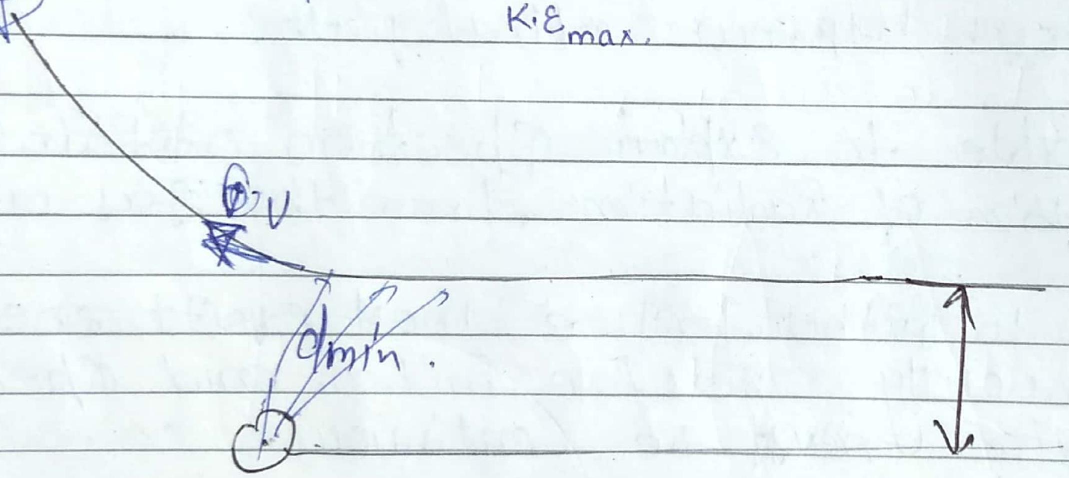
Energy Conversion

$$0 - K.E_{max} = \frac{-kze(e)}{d_{min}} \to 0$$

$$d_{min} = \frac{kze^2}{E_{max}(\tau)}$$

$$d_{min} = \frac{kze^2}{K.E_{max}}$$

Q.2



$$\frac{1}{2} m v_f^2 - K.E_{max} = \frac{kze^2}{d_{min}} \quad (1)$$

$$m v_0 b = m v_f d_{min} \quad (2)$$

* Bohr Model :-

[1] Bohr Postulate :- $e^{\ominus}$ orbit around a nucleus in a fixed Path/orbit in which $e^{\ominus}$ will neither emitt ~~or~~ absorve Energy while Rotating in Rotating orbit.

[2] Angular momentum of a $e^{\ominus}$ orbiting in a orbit is integral multiple of $\frac{h}{2\pi}$.

$$\boxed{n\lambda = mvr}$$

$$n\lambda = 2\pi r$$

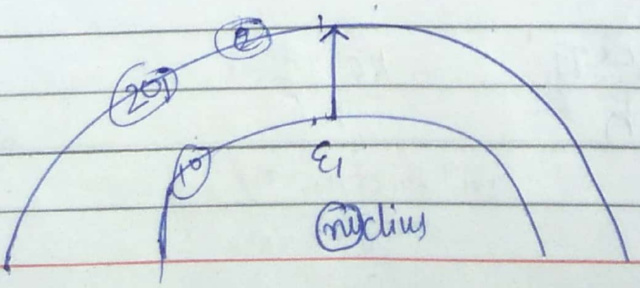
$$\frac{n}{2\pi}\frac{h}{v} = r$$

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

when n is no. of Orbit.

[n - Principle Quantum no, $n \in (1,2,3)$]

[3] When ever $e^{\ominus}$ in an orbit Changes its orbit it will Radiate or absorve energy in fixed amount (Quanta). Which is equal to diff. in energy of the two orbit



absorvitity ⇒ ↑ absorve light

$E_2 - E_1$

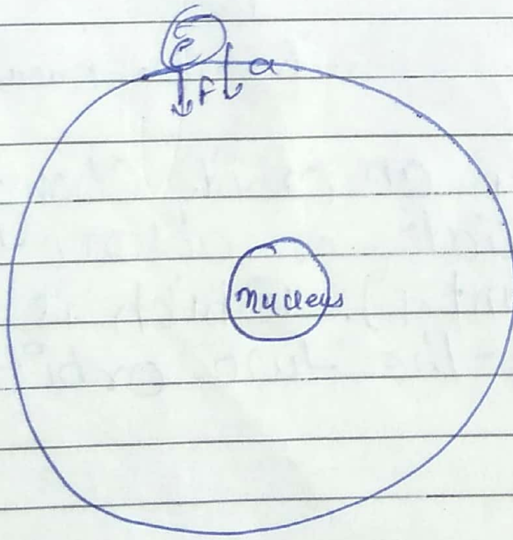
$$\boxed{\Delta E = \frac{hc}{\lambda}}$$

$$\boxed{\lambda = \frac{hc}{\Delta E}} \quad \text{OR} \quad \boxed{\lambda \text{ in } \mathring{A} = \frac{12400}{\text{Energy in eV}}}$$

When $e^{\ominus}$ moves to lower (close to nucleus) orbit Energy is emitted

(4) Various Parameter for Hydrogen like atom acc. to Bohr :-

(i) Velocity of the electron in an orbit :



$f = ma$

$$\frac{kze^2}{R^{\cancel{2}}} = \frac{mv^2}{\cancel{R}}$$

$$kze^2 = mv^2R \quad \text{--- (1)}$$

$$\frac{nh}{2\pi} = mvR \quad \text{--- (2)}$$

dividing (1) and (2)

$$\frac{kze^2}{R} = \frac{mv^2}{R}$$

$$kze^2 = mv^2R$$

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

$$V = \frac{kze^2 2\pi}{nh}$$

$$\frac{ke^2 2\pi}{h}$$

Bohr orbit

$$= \frac{9 \times 10^9 \times (1.6)^2 \times (10^{-19})^2 \times 2 \times 13.14}{6.103 \times 10^{-23}}$$

Imp.

$$\boxed{V = \frac{Z}{n} V_0} \Rightarrow \boxed{V_0 = 2.19 \times 10^6 \, m/s}$$

Radius of orbits:

$$F = ma$$

$$\frac{KZe^2}{R^2} = \frac{mv^2}{R}$$

$$KZe^2 = Mv^2R \quad \text{--- (1)}$$

$$\frac{n^2h^2}{4\pi^2 Z^2}... $$

$$\frac{n^2h^2}{\pi^2 2^2} = M^2v^2R^2 \quad \text{--- (2)}$$

$$\boxed{R = \frac{n^2h^2}{4\pi^2 mkZe^2}}$$

$$\boxed{R = \frac{n^2}{Z} \times 0.53}$$

$$\boxed{V = \frac{Z}{n} \times 2.19 \times 10^6}$$

$$\boxed{R = \frac{n^2}{Z} r_0}$$

where $\boxed{r_0 = 0.53 \, A_0}$

or $0.53 \times 10^{-10} \, m$

Energy of different orbit in Atom:

$$T.E = K.E + P.E$$

$$F = ma$$

$$\frac{1}{2} \frac{KZe^2}{R^2} = \frac{mv^2}{R} \frac{1}{2}$$

Eyes — Ocr

↓ 4000 – 7000 ↑ Not Visible

Not visible

8000 Å – 9000 — Days sec

HCV Photo Elec

1 to 20 D-Broglie S-1 O-1

$$T.E = KE + P.E$$

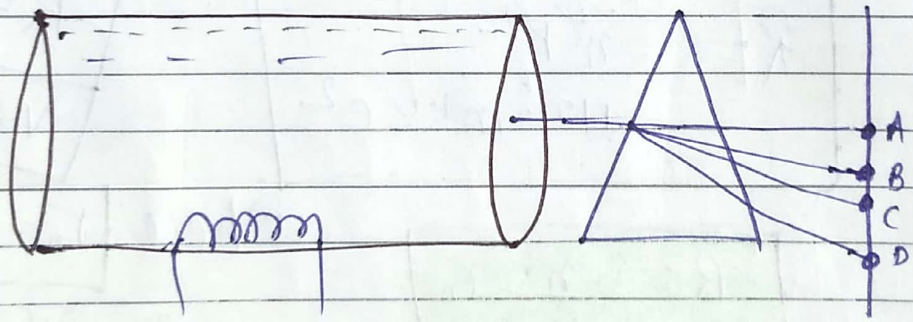
$$= \frac{kze^2}{2R} - \frac{kze^2}{R}$$

$$E = \frac{z^2}{n^2}$$

$$T.E = -\frac{kze^2}{2R} = -\frac{z^2}{n^2}\left[\frac{ke^2}{2r_0}\right]$$ (for H)

$$\boxed{E = \frac{-z^2}{n^2}[13.6\ eV]}$$

* Spectrum obtained by H ~~atom~~ gas:



Under normal condition the single e^- in H atom stays in ground state $n=1$

It is exiceted to sum higher energy state when it aquires some energy from external source but it hardly stage their for more than 10^{-8} sec

$$\boxed{E = -\frac{Z^2}{n^2} \times 13.6}$$

Photons corresponding to a particular spectrum line is emitted when ~~an~~ $e^{\ominus}$ ~~atom~~ makes an transition ~~state~~ ~~in~~ from particular higher energy state to lower energy state.

These lines obtained will form spectral / spectrum emission spectrum.

$$\boxed{E = -\frac{Z^2}{n^2} \times 13.6}$$

13.6/36 — 0.38 ev

13.6/25 — 0.51 ev

13.6/16 — 0.85 ev

13.6/9 — -1.51 ev

$\frac{13.6}{4}$ — -3.4 ev

13.6/1 — -13.6 ev

Spectrum obtained by hydrogen

U.V ← Lyman, Balmer → visible

Paschen, Brackett, Pfund } Infra.

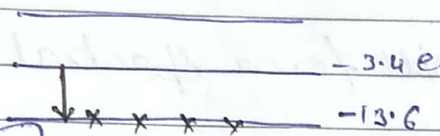
[LB PB P]

$E \downarrow \quad \lambda \uparrow$

near Jumb.

* **Lyman:** $n = 1$ $\quad E = \frac{hc}{\lambda}$ $\quad \lambda = \frac{hc}{(E_2 - E_1)}$

$$= \frac{12400}{(\quad)}$$



Series Limit

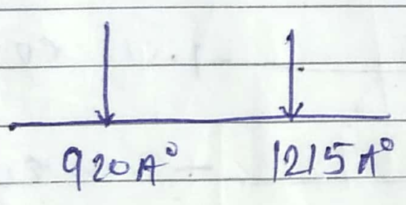
$$\lambda_{Biggest} = \frac{12400}{10.2}$$

$$= 1120 \text{ A}^\circ$$

$$\simeq 1200 \text{ A}^\circ = 1215 \text{ A}^\circ$$

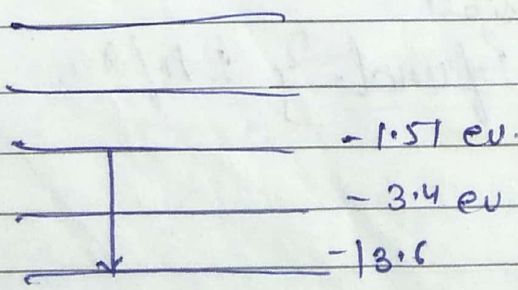
$$\lambda_{smallest} = \frac{12400}{13.6}$$

$$\lambda = 920 \text{ A}^\circ$$



Series Limit

(*) **Balmer** ⇒ $n = 2$.



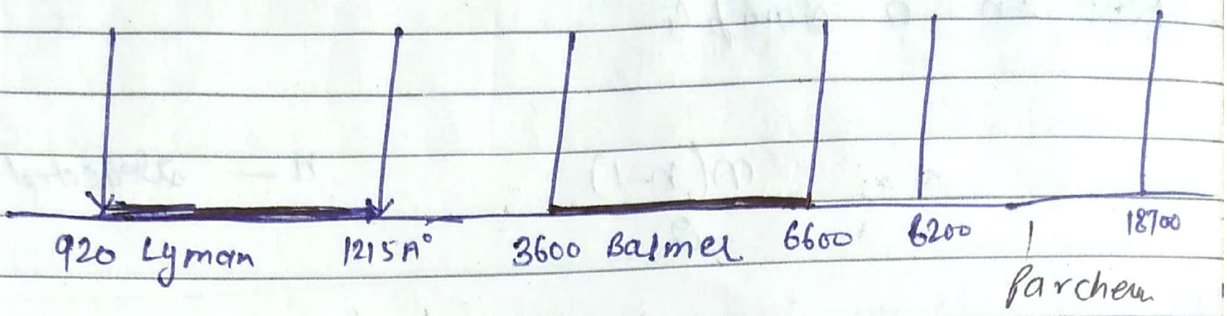
$$\lambda_{Biggest} = \frac{12400}{1.89}$$

$$= 6600 \text{ A}^\circ$$

$$\lambda_{smallest} = \frac{12400}{3.4}$$

$$= 3650$$

$$\begin{array}{r} 13.6 \\ 1.51 \\ \hline 12.1 \end{array}$$



* **Parchen :** $n = 3$

λ_{smalls} (~~Biggest~~) $= \dfrac{12400}{1.51}$

$= 8266.$

λ_{Biggest} (~~smallest~~) $= \dfrac{12400}{0.66} = 18787$

λ Biggest $=$

$=$ ~~8200~~ $= 18700$

λ min $= 8200$

* **Brackets :** $n = 4$

* **Pfunds :** $n = 5$

123 − 143

(21)

Total wavelength $= \frac{\cancel{6}^{3} \times 5}{1 \times 2} = 15$

Q. In a sample

$\frac{n(n-1)}{2}$ n — selected.

$= {}^4C_2$

$\cancel{\#} - \cancel{7}$

$15 - 7$

${}^9C_2 = 36$ lines

$(\cancel{1} + 1\ n_2 - 1 + 1)$

$\boxed{{}^{n_1 - n_2 + 1}C_2}$

${}^4C_2 = \frac{4 \times 3}{1 \times 2}$

$\boxed{\text{No. of Spectrum line} = {}^nC_2}$

Que: ~~Find on I series~~

find the wave length of the Radiation Required to exist the $e^{\ominus}$ in Li^{++} from 1st to the 3rd Bohr orbit

(2) How many spect. line observed in the

(2) ${}^3C_2 = \frac{3 \times \cancel{2}}{\cancel{2} \times 1} = 3$ Ans

H.W ? S-1 O-1 Bohr Race Penalty 67.

① $\lambda = \frac{12400}{}$ $n = 3$ $\frac{124000}{14} = 1$

$\frac{13.6}{9}$
$= 1.4$

Ans: ①

———— 1.5×9

———— 3.4×9

———— 13.6×9

$Li = 3 \times 3 = 9.$

$\lambda = \frac{12400}{9 \times 12.1} = \frac{12400}{108.9}$

$= 113.$

Q. A Li atom has $3e^{\ominus}$ assume the followo $2e^{\ominus}$ moves g to the nucleus makeing up a spherical clouds and 3rd moves outside the clouds in a circular orbit. Bohr model can be used

Ans: But n = 1 state are not avivalblee to it find Ionisation Energy for this atom.

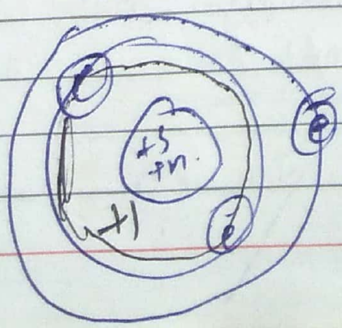
Ans: 3.4 eV.

$Z = 1$

———— 9×1.5

———— 9×3.4

———— 9×13.6



Ans = 3.4 eV.

absorve ↑

Very Important

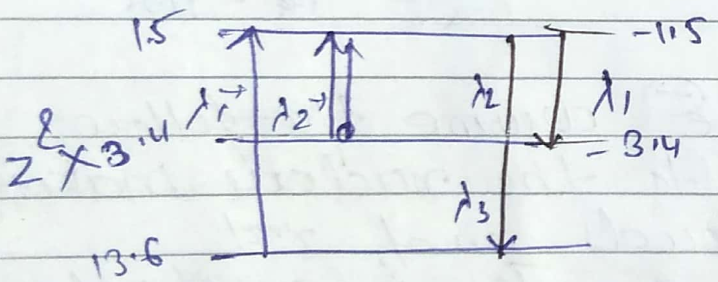
Que:- A gas of hydrogen like atom can absorve radiation of 68 eV Consiquently the emitts radiations only three diff wave length all the wave length are equal or smaller then that of absorve photone

(A) determine the initial state of gas Atom
(B) Identify the gas atom.
(C) find minimum wave length of emitted radiation
(D) find the ionisation energy and respectively wave length of gas atom.

Ans: $P = \frac{E}{c}$ $\quad E = \frac{hc}{\lambda} \quad \lambda = \frac{hc}{E}$ $\quad \Rightarrow E = \frac{hc}{\lambda}$

$\frac{n(n-1)}{2} = 3 \quad = \quad n(n-1) = 6$

$n = 3$ absence line.



$\lambda = \frac{hc}{\Delta E}$

$\lambda_2 > \lambda_3 > \lambda_1$

$Z^2 \times 3.4 = 68$

$Z^2 = \frac{680}{34} = 20$

$Z^2 = 20$

$Z = \sqrt{20}$

$= \frac{680}{19}$

M — initial State = 2.

$Z^2 [3.4 - 1.5] = 6.8$

$Z^2 = \frac{68}{1.9} \approx 36.$

$Z = 6$

Carbon.

$\frac{hc}{\lambda} = \frac{h}{p}$

$\lambda^2 \times E$ ——— $36 \times$

——— 36×0.5

——— 36×0.84

——— 36×1.51

——— 36×3.4

——— 36×13.6

$\uparrow E = \frac{hc}{\lambda \downarrow}$

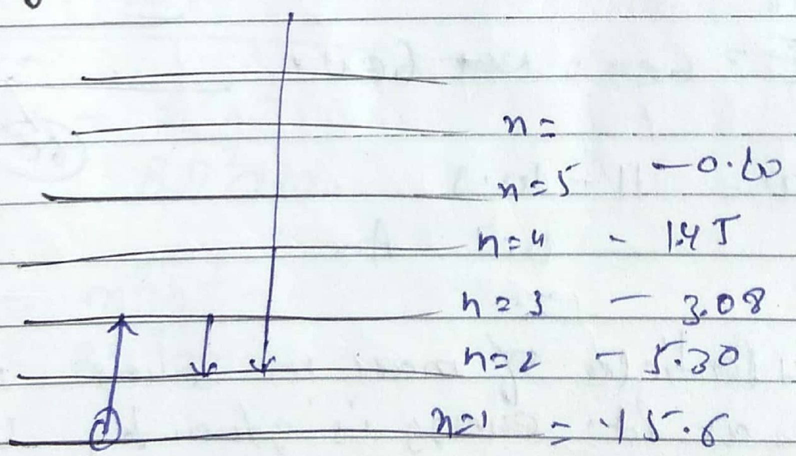
$\downarrow E \quad \lambda \uparrow$

(3) $\lambda = \frac{hc}{E} = \frac{12400}{36[12.1]} = 28.49$

$= \frac{12400}{36 \times 13.6}$ — Gro ∞. Exist

(4) 480.96

Que Energy level of



(1) find ionsiation of −15.6 eV

(2) f a the short wave length limit of the series at n = 2

Small $\lambda_{small} = \frac{12400}{8.3}$ $\quad \lambda_{big} = \frac{12400}{5.30}$

Big

find $\boxed{\text{Wave no} = \frac{1}{\lambda}}$ Bohr orbit

(3) Excitation pot. for n=3.

15.6 − 3.08.

(4) Wave no. of wave no. of the photone emitted

$n = 3 \longrightarrow n = 1$

Wave length.

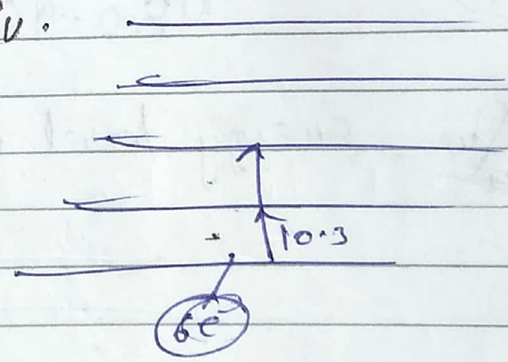
$\text{Wave no} = \frac{1}{\lambda}$ (Ex= $\frac{1}{\lambda}$)

$\lambda = \frac{12400}{15.6 - 3.08}$

=

(5) (i) min. energy of $\bar{e}$ will held after interacting with this atom in ground state if the K.E of the $\bar{e}$ is 6 eV.

(ii) 11 eV. ⇒



Ans (i) E = 6ev = ~~Not~~ 6ev.

(ii) 11 ev = 11 − 10.3
= 0.7 Ans

Q. A small Particle of mass m whose in such as Pot. energy is given by $U = ar^2$ where a is Const and r is the dist. of the particle from the origin. assuming Quantization of angular moment to be True. find radius of the Bohr orbit.

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

qvB — Magnetic force

~~mvr = nh~~

$$\boxed{mvr = \frac{nh}{2\pi}}$$ ← Quantised

angular momentum.

$$\frac{Kze^2}{r^2} = \frac{Mv^2}{r} \times$$

$$f = \frac{dy}{do}$$

$$u = ar^2$$

$$f = \frac{dy}{dr} = 2ar$$

$2ar \Rightarrow quB$ for magnetic Momentum.

$$Mv^2 = 2ar^2 \quad \text{(II)}$$

i eq square and devide.

$$m^2\cancel{v^2}r^2 = \frac{n^2h^2}{4\pi^2}$$

$$\frac{n^2h^2}{2^2 \times 2 \times \pi^2 \times a \times \cancel{r^2}}$$

$$\frac{n^2h^2}{8\pi^2 \times a\,m.}$$

$$m\cancel{v^2} = 2ar^2$$

$$mr^4 = \frac{n^2h^2}{8\pi^2 am.}$$

$$r = \frac{n^2h^2}{8\pi^2 am}$$

Race − ~~64~~, 67, 68, 64

Collision − Not heat

Non Elastic − Not loss

(ii)

* Atomic Collision :

Δk.E — Total

In collision b/w two object ↑ k.E of the system decreases in k.E will convert into Energy of deformation (Potential Energy). But in atoms this energy is used to exict $e^{\ominus}$

Loss

$$\boxed{\Delta k.E = \frac{1}{2}\left(\frac{M_1 M_2}{M_1+M_2}\right) V_{rel}^2\left[1-e^2\right]}$$

Que: Fast moving neutron Collides with H atom at rest if K.E of a nutron is 14 keV

(ii) 20.4 eV

(iii) 22 eV.

(iv) 24.2 eV.

find Nature all the atomic Collision.

(i) Not heat Loss ⇒ Complete elastic collision.

$= \frac{1}{2} \times 14 = 7$

must be

0.5, 0.85, −1.51, −3.4, −13.6

$\frac{1.51}{0.7}$

(n) −1v (H)

$$\Delta E = \frac{1}{2}\frac{m(m)v^2}{2m}\left[1-0^2\right] =$$

$$\Delta E = \frac{1}{2} m v^2$$

$e > 0 \neq 1$

(ii) $\frac{1}{2} \times 20.4 = 10.2$ $\quad e = 0$

May be Completely Inelastic Collision

(iii) $\frac{1}{2} \times 22 = 11$ $\quad e \neq 0$

In this Case may be $1 \geq e > 0$

$e > 0 \quad e \leq 1$

(iv) $= \frac{1}{2} \times 24.2 = 12.1$

May be.

Q. A fast moving neutron Collides with ~~Hydrogen~~ Helium atom at rest what must be the Kinetic E. of neutron for complete inelastic Collision given that Helium atom double Ionised.

Sol^n:

$$\boxed{= \Delta E = \frac{1}{2} \frac{2m^2 v^2}{3m}[1-0^2] = \frac{1}{3} mv^2 \quad \times}$$

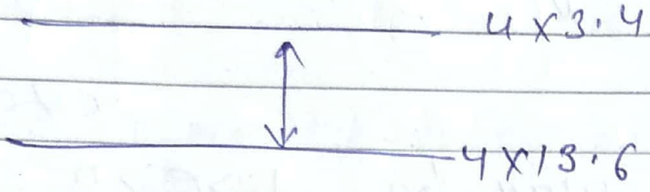
$$\boxed{= \frac{1}{2} \frac{4m^2 v^2}{5m}[1-0^2) = \frac{2}{5} mv^2}$$

$$= \frac{1}{2} \frac{m \cdot 4m}{5m} v^2 [1-0]$$

$k = \longrightarrow \frac{4}{5} k.$

Not in chemistry

$k \longrightarrow \frac{4}{5}k$



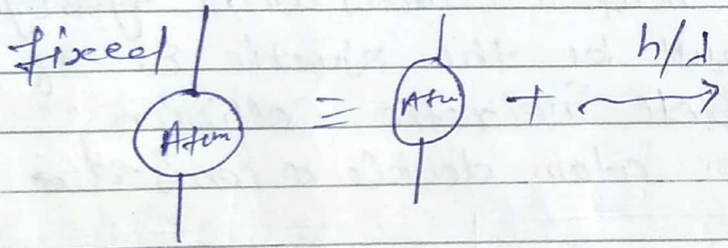
$K = \frac{4}{5}K = 40.8.$

$K = 51\ ev.$

Not fair

* Recoiling of atom :

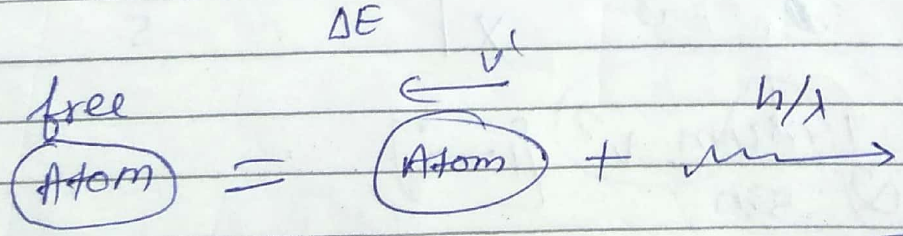
(1) fixed



$E_2 - E_1 = \frac{h}{\lambda}$

$\lambda = \frac{h}{\Delta E}$

(2) free



$0 = mv' + \frac{h}{\lambda'}$ — (1) $\boxed{\text{momentum conserved}}$

$E_2 - E_1 = \frac{1}{2}mv'^2 + \frac{hc}{\lambda_1}$ — (2)