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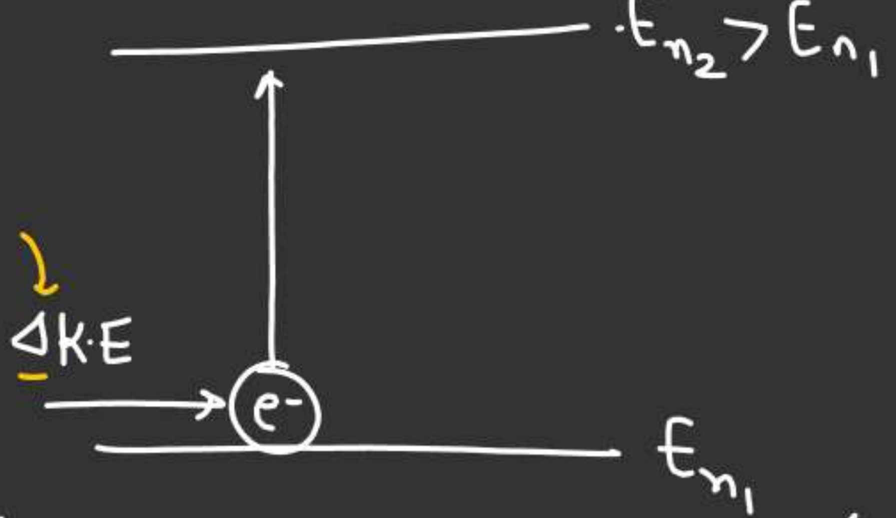
ATOMIC COLLISION

In atomic collision, if collision is inelastic or perfectly inelastic then then difference in the kinetic energy is utalized for excitation of atom or electron

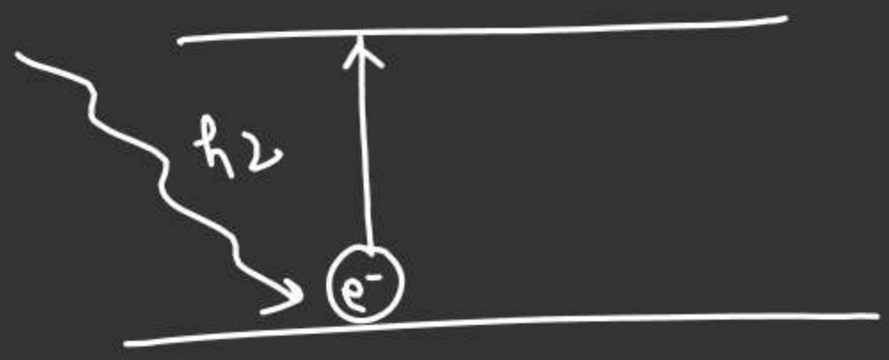
(Atomic collision Excitation)



$$[K.E_i - K.E_f] = \Delta K.E$$

For transition

$\Delta K.E \geq \Delta E$



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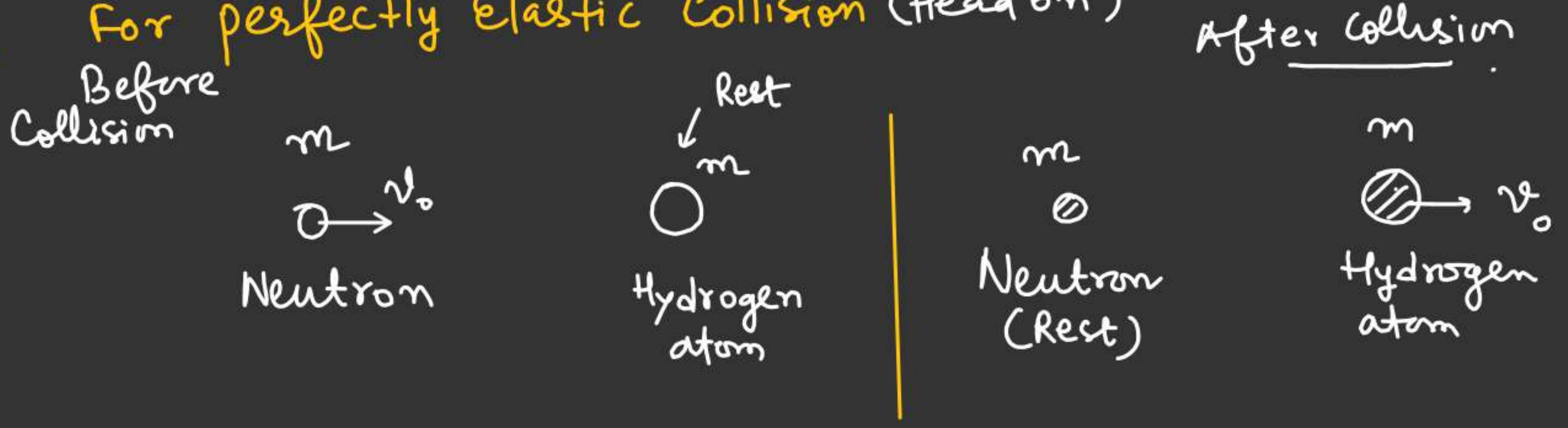
Collision b/w Neutron and Hydrogen atom

Case-1 For perfectly Elastic Collision (Head on)



$$K.E_i = K.E_f$$

$$\underline{\Delta K.E = 0}$$

No excitation of hydrogen atom.

Perfectly inelastic Collision

After collision.

L.M.C

$$m v_0 = 2m v_c$$

$$v_c = \left(\frac{v_0}{2}\right)$$

$$K.E_i = \frac{1}{2} m v_0^2$$

$$K.E_f = \frac{1}{2}(2m) V_c^2 = \frac{1}{2}(2m)\frac{v_0^2}{4}$$

$$K.E_f = \left(\frac{1}{2} m v_0^2\right) \times \frac{1}{2} = \left(\frac{K.E_i}{2}\right)$$

$$\left(\Delta K.E = \frac{K.E_i}{2}\right)$$

$$\Delta K.E = \left(\frac{K.E_i}{2}\right) = \frac{1}{4} m v_0^2$$

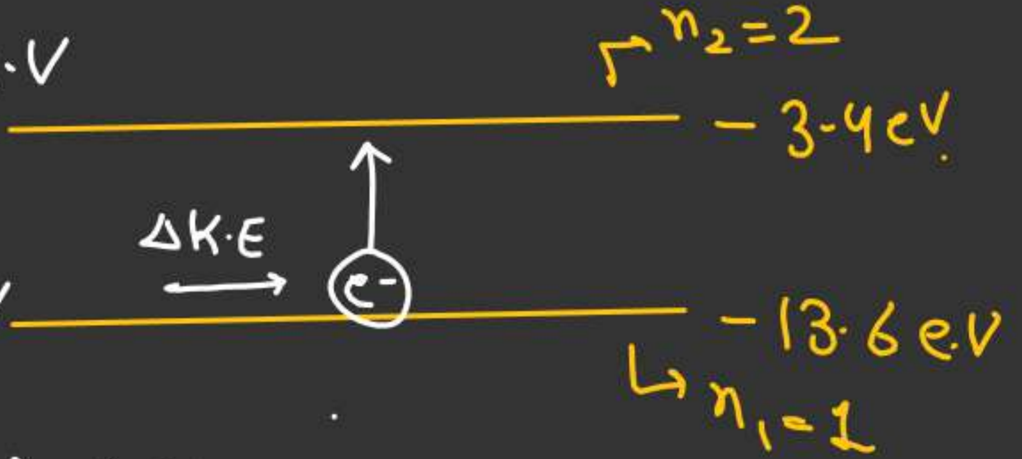
$\Downarrow$

Utalized by electrons of hydrogen atom for transition to higher energy level.

$$\Delta K.E \geq 10.2\,eV$$

$$\frac{(K.E_i)}{2} \geq 10.2\,eV$$

$$K.E_i \geq 20.4\,eV$$



$$(K.E_i)_{min} = 20.4\,eV$$

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What type of Collision is possible b/w Neutron & Hydrogen atom if initial Kinetic energy (K) is

$K = 14\,eV$, $20.4\,eV$, $22\,eV$, $24.18\,eV$

Hydrogen Atom

$12.09 \simeq 12.1$

$\bullet \rightarrow K$ (H) Rest

For transition

$\Delta E = [0,\ 10.2\,eV,\ 12.1\,eV \ldots$

$\Delta K.E = \frac{K}{2}$

if $K = 14\,eV$

$\Delta K.E = [0,\ 7\,eV] \Rightarrow$ No transition (Elastic Collision)

If $K = 20.4\,eV$

$\Delta K.E = \frac{K}{2} = 10.2\,eV \rightarrow$ [transition from $n_1 = 1$ to $n_2 = 2$] $\rightarrow$

$[0 \leq 10.2\,eV]$

If $\Delta K.E = 0 \Rightarrow$ Elastic

$\Delta K.E = K_i/2$ = Perfectly Inelastic

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$K_i = 24.18.$

$\Delta K.E = \frac{K_i}{2} = (12.09)$

3 - Case possible

If $\Delta K.E = 0 \Rightarrow$ Perfectly Elastic

If $\Delta K.E = 10.2 \Rightarrow$ Perfectly inelastic & transition from $n_1 = 1$ to $n_2 = 2$

If $\Delta K.E = 12.09 \Rightarrow$ Perfectly Inelastic & transition from $n_1 = 1$ to $n_2 = 3$

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Case of Collision b/w Hydrogen and Helium ion

$\underline{K.E_i = K}$

$\Downarrow$

Initial K.E of hydrogen atom

m

Hydrogen atom

$4m$ $\;{}^4_2He$

(Rest)

After Collision

m $\quad 4m$

Hydrogen atom Helium ion

$$K.E = K = \frac{1}{2}mv^2$$

$$K = \frac{p^2}{2m}$$

$$\left(p = \sqrt{2mK}\right)$$

$$p_i = p_f$$

$$mv_i = 5mV_c$$

$$V_c = \left(\frac{v_i}{5}\right)$$

$$K.E_f = \frac{1}{2}(5m)V_c^2 = \frac{1}{2}(5m)\frac{v_i^2}{25}$$

$$K.E_f = \left(\frac{1}{2}mv_i^2\right)\times\frac{1}{5} = \frac{K.E_i}{5} = \frac{K}{5}$$

$$\Delta K.E = K - \frac{K}{5} = \left(\frac{4K}{5}\right)$$

$\Downarrow$

(Loss in Kinetic energy)

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$$(\Delta K.E) = \left(\frac{4K}{5}\right)$$

$$E = -\frac{13.6\, Z^2}{n^2} (e.V)$$

For He^+

$$E = -\frac{13.6 \times (2)^2}{n^2}$$

He^+

$$|\Delta E|_{min} = |E_1 - E_2|$$

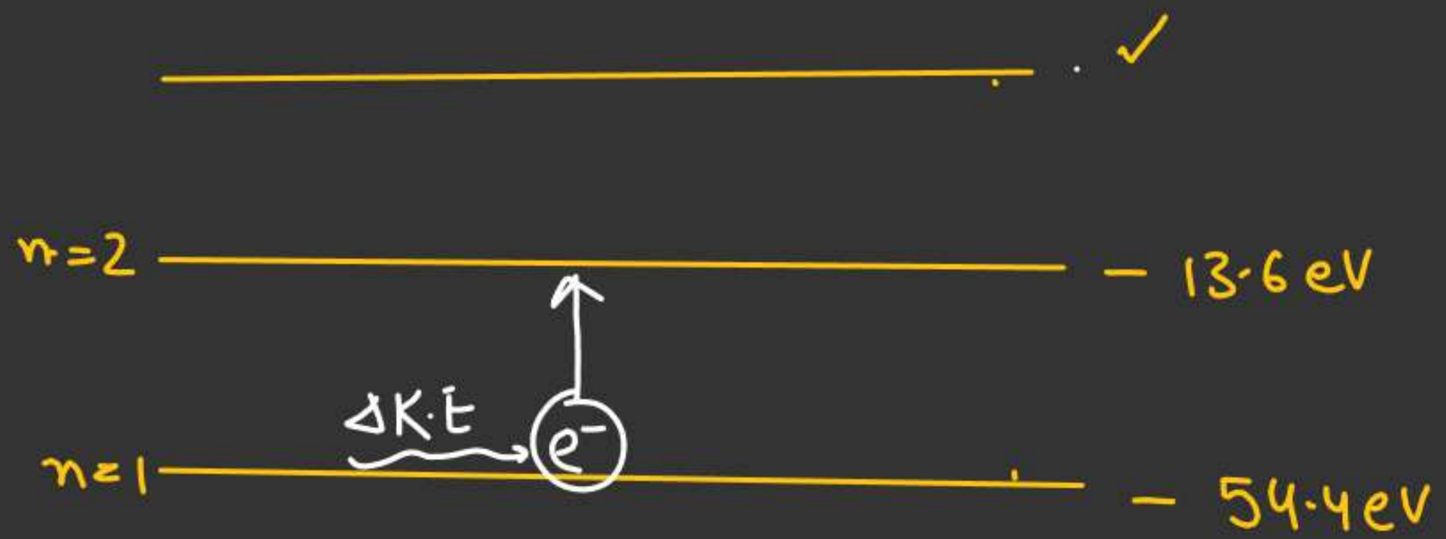
$$= [54.4 - 13.6]$$

$$= \underline{40.8\ e.V}$$

$n = 1$

$$E_1 = -\frac{13.6 \times 4}{1}$$

$$= -54.4\ e.V$$



$$\Delta K.E \geq (\Delta E)_{min}$$

$$E_2 = -\frac{13.6\,(2)^2}{(2)^2} = -13.6\ e.V$$

$$\frac{4K}{5} \geq 40.8\ e.V$$

For $\underline{K_{min}}$.

$$\frac{4K_{min}}{5} = 40.8\ e.V \Rightarrow K_{min} = \left(\frac{40.8 \times 5}{4}\right) e.V$$

$$= (10.2 \times 5)\ e.V$$

$$= \underline{51\ e.V}$$

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Collision b/w Hydrogen and Helium ion so that both excite from ground state

$\Delta K.E = \left(\frac{4K}{5}\right)$

For Hydrogen

$\Delta E_{min} = 10.2eV$

For Helium :

$(\Delta E)_{min} = (40.8\ e.V)$

$(\Delta E_T)_{min} = (40.8 + 10.2)\ e.V$

$= 51\ e.V$

↳ For both hydrogen atom & Helium to excite from ground state.

$\Delta K.E \geq 51$

$\frac{4K}{5} \geq 51$

$K \geq \frac{51 \times 5}{4}$

$K \geq 63.75eV$

$K_{min} = 63.75 e.V$

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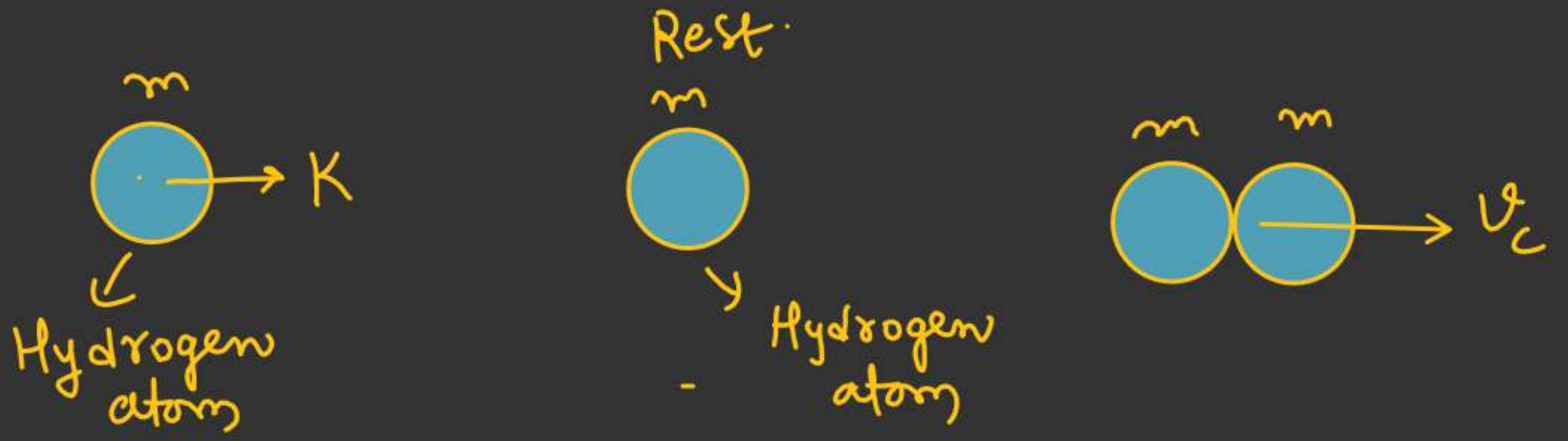
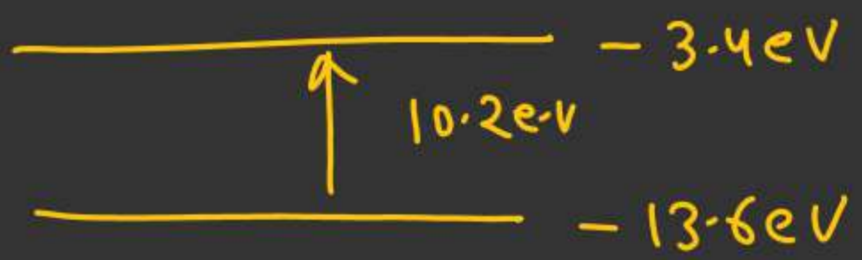
Q4 → Collision b/w two Hydrogen atom in ground State.





$\frac{K}{2} \geq 10.2$ e-V

$mV_0 = 2mV_c$

$V_c = \frac{v_0}{2}$

$K \geq 20.4$ e-V ✓

$K \cdot E_f = \frac{1}{2}(2m)V_c^2 =$

$m\left(\frac{v_0^2}{4}\right) = \frac{K}{2}$

$K_{min} = 20.4$ e.V

$\Delta K \cdot E = \frac{K}{2}$.

→ At least one of the hydrogen atom get excite.

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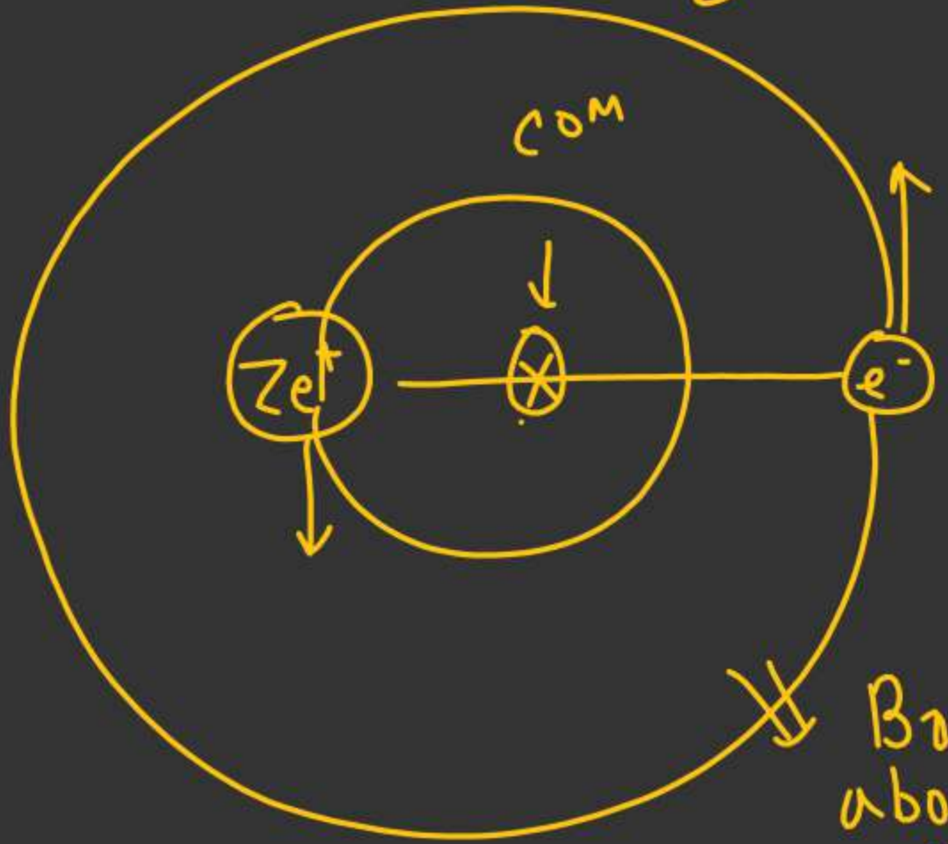
Concept of Reduced mass.

If Ze & e of Compariable Mass.



Both move about their Common COM