'ATOMIC STRUCTURE'

Spectrum of a Matter.

When a body is heated It emits Radiation, which consist of various Wave length, When these Wavelength are ploted against a calibrated scale then, this part is called spectrum of Matter.

In case of Hydrogen radiation of 6562 A° & then radiation 4860 A° was obserbed, these lines denoted the spectrum of Hydrogen.

Bohr Model of Hydrogen like atom → This model was developed Specifically for hydrogenic atom which const of 1e⁻.

Ex → H - atom, He^{+}, Li^{++}

NOTE → Although bohr model seems appropriate for hydrogen like atom & it is able to explain line of spectrum but still it doesn't give the true picture of even H-atom.

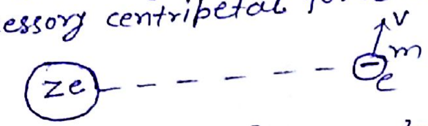
The true picture is derived from quantum mechanics affair which is different from Bohr Model in 2 fundamental way.

* **1st postulate →**

* Mass of nucleus is very large.

* e^- is orbiting in circular orbit.

A/c * Necessory centripetal force is given by coulumbing attraction.



$$\frac{1}{4\pi\epsilon_0}\frac{ze^2}{r^2} = \frac{mv^2}{r} \quad \text{—①}$$

$$\boxed{mv^2 = \frac{ze^2}{4\pi\epsilon_0 r}}$$

* **2nd postulate →**

* Angular Momentum of e^- is integral multiple of $\frac{h}{2\pi}$ or $\hbar$.

For nth orbit, $\boxed{mvr = \frac{nh}{2\pi}}$ —②

orbital angular momentum of e^- could not have any value A/c to this postulate. While moving around these stable orbit charged particle does not emit any kind of Electromagnetic Radiation, Energy of e^- is const.

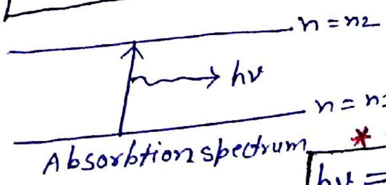
* **3rd postulate →**

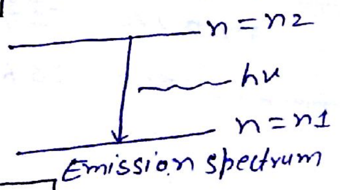
$$P.E = \frac{1}{4\pi\epsilon_0}\frac{ze^2}{r} \quad \text{(For nth orbit)}$$

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

E_{Total} = K.E + P.E = const. for a stable orbit.

$$\boxed{E_{Total} = \frac{1}{2}mv^2 - \frac{ze^2}{4\pi\epsilon_0 r}}$$





$$\boxed{h\nu = E_{n2} - E_{n1}}$$

* Radius of orbit →

$$r = \frac{n^2 h^2 \epsilon_0}{\pi m Z e^2} = 0.53 \frac{n^2}{Z} A^\circ$$

* velocity of e^- in nth orbit →

$$V = 2.18 \times 10^6 \frac{Z}{n} \text{ m/sec}$$

(i) → current in nth orbit $\propto Z^2/n^3$
(ii) → Time period of nth orbit $\propto n^3/Z^2$
(iii) → Angular Momentum (ω) $\propto Z^2/n^3$
(iv) → Magnetic Induction ($\vec{B}$) $\propto Z^3/n^5$
(v) → Magnetic moment ($\vec{\mu}$) $\propto n$

* current $= i = 2 \frac{V}{2\pi r} e$
* Time period $= T = \frac{2\pi r}{V}$
* $\omega = \frac{V}{r}$
* $B = \frac{\mu_0 i}{2r} \propto \mu_0 \frac{Z^2}{n^3} \frac{\times Z}{\times n^2}$
* $\mu = iA = i \times \pi r^2 \propto \frac{Z^2}{n^3} \times \frac{n^4}{Z^2} \propto n$

Total energy in nth orbit

$$PE = \frac{-1}{4\pi\epsilon_0} \frac{Ze^2}{r}$$

$$K.E = \frac{1}{2} m v^2 = \frac{1}{2} \frac{Ze^2}{4\pi\epsilon_0 r}$$

$$K.E = \frac{1}{2} |PE| = -\frac{1}{2} PE$$

$$E_n = \text{Total energy} = K.E + PE = \frac{PE}{2} = -\frac{Ze^2}{8\pi\epsilon_0 r}$$

$$E_n = -13.6 \frac{Z^2}{n^2} eV$$

$$= 13.6 = Rhc$$

1 Rhydberg Energy $= 13.6 ev \Rightarrow R = \frac{2\pi^2 m k^2 e}{ch^3}$

Rhydberg const $= R = \frac{2\pi^2 m k^2 e^4}{ch^3} = 1.09 \times 10^7 m^{-1}$

Different Energy level.

$n = 3$, $E_3 = \frac{-13.6}{9} Z^2$

$n = 2$, $E_2 = \frac{-13.6}{4} Z^2$

$n = 1$, $E_1 = -13.6 Z^2$

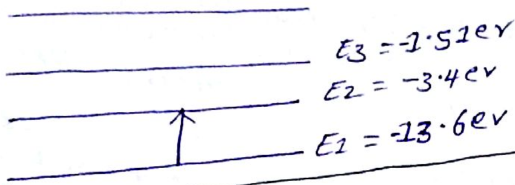
** → For H-atom →

AIIMS

$E_1 = -13.6\,ev$
$E_2^* = -3.4\,ev$
$E_4 = -0.85\,ev$
$E_5 = -0.54\,ev$

Excitation of e^- in an atom → Whenever an e^-, in lower energy state or, ground state get some energy from external source it may make a transition to a energy level, this process is called excitation & the upper or, heigher energy state of e^- is termed as excited state.

For Ex – Hydrogen atom



** For excitation to $n=2$
i.e '1st excited state' (AIR 2016, AIIMS)
$\Delta E = E_2 - E_1 = 10.2\,eV$

For excitation to $n=3$
i.e 2nd excited state.
$\Delta E = E_3 - E_1 = 12.09\,ev$

e^- can absorb energy in the form of photon or, form of calliding partide –

(i) → From photon → An e^- will absorb photon only of the energy 10.2 eV, 12.09 ev, 12.75 ev - - - - for its excitation.

(ii) → From calliding partide → The collision with the calliding partide must be inelastic so that K.E lost during the callision can be used to excite the atom.

We can use fallowing Law –

(a) → conservation of Linear Momentum.

(b) → conservation of Energy.

Ionisation Energy or, Ionisation potential : → For H-atom.

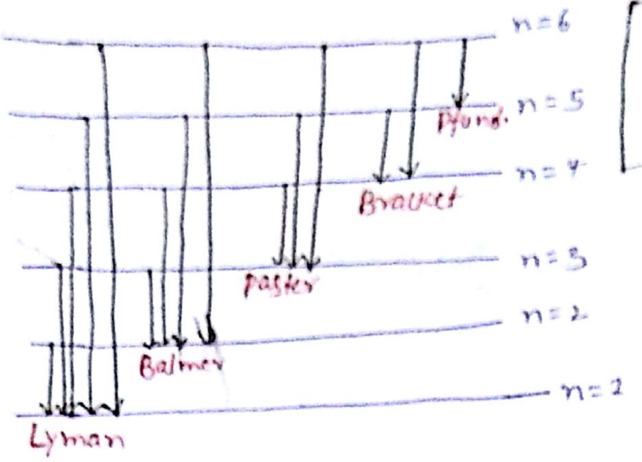
Min energy needed to remove the e^- from Ground State.

** $E = 13.6\,ev \Rightarrow B.E$ of e^-

Ionisation pot. is the min pot. through which an e^- must accelerate before making callision with the e^- of H-atom to knock out it.

Scanned by CamScanner

Spectral line of H-atom



NOTE →
* For e^- in nth state, spectral line = $^nC_2$
* Max no. of photon Emitted = n − 1

NOTE → * No two element will have identical spectral line, since no two element have identical energy level. Therefore the in of sp. of element described as fingerprints of atom differing from each other like finger prints of Human.

* In H-atom an e^- jumps from six energy level to 1st excited state. The no. of lines crossponding to the Lyman series are → zero, bcoz e^- is not jumping in Ground state.