ARJUNA NEET BATCH

Structure of Atom

LECTURE - 10

BY : DOLLY SHARMA

Quick Recap

$\Rightarrow$ debroglie wavength (λ) $= \frac{h}{mv}$

$\Rightarrow$ $\lambda \propto \frac{1}{v}$, $\lambda \propto \frac{1}{m}$

$\Rightarrow$ $\lambda = \frac{h}{\sqrt{2m\,K.E.}}$, $\lambda \propto \frac{1}{\sqrt{K.E.}}$

$\lambda = \frac{h}{\sqrt{2meV}}$ or $\lambda \propto \frac{1}{\sqrt{V}}$

Heisenberg Uncertainity Principle

$\Rightarrow$ $\Delta x \times \Delta p \geq \frac{h}{4\pi}$

$\Rightarrow$ $\Delta x \times \Delta v \geq \frac{h}{4\pi m}$

Objective of today's class

QUANTAM MECHANICAL MODEL OF AN ATOM ,QUANTUM NUMBERS

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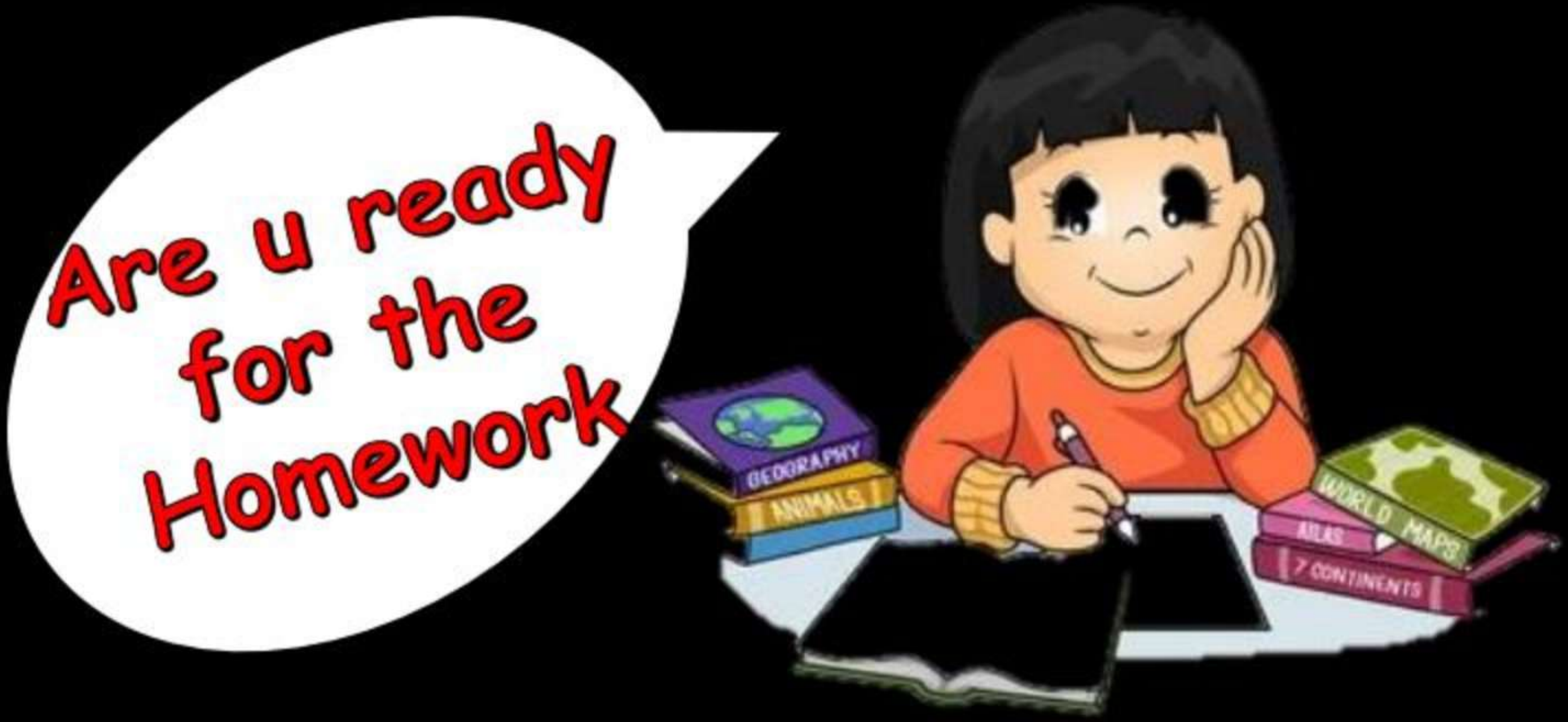

Are u ready for the Homework
GEOGRAPHY
ANIMALS
WORLD MAPS
ATLAS
7 CONTINENTS

Q. An $e^{\ominus}$ has a speed of 4×10^5 m/s. If its velocity is accurate upto 10% then calculate uncertainty in position of $e^{\ominus}$.

$V = 4 \times 10^5$ m/s $\Rightarrow \Delta V \Rightarrow 4 \times 10^5 \times \frac{9\cancel{0}}{10\cancel{0}} \Rightarrow 36 \times 10^4$ m/s

$\Delta x = ?$

$\Rightarrow$ Acc. to H.U.P. $\rightarrow \Delta x \times \Delta V \geq \frac{h}{4\pi m}$

$\boxed{100}$

10%

90%

$$\Rightarrow \Delta x = \frac{6.626 \times 10^{-34}}{4 \times 3.14 \times 9.1 \times 10^{-31} \times 36 \times 10^4}$$

$\Rightarrow \Delta x =$

Q. When Electromagnetic Radiation of wavelength 300nm fall on surface of sodium. $e^{\ominus}$ s are emmitted with the K.E. of 1.68×10^5 J/mole. What is the minimum energy needed to remove an $e^{\ominus}$ from Na(Sodium) & what is the maximum wavelength that with cause of photo electrons to be emmitted.

$\lambda_i = 300\,nm$

$K.E. \Rightarrow 1.68 \times 10^5$ J/mole.

$E_0 = \omega = ?$

Photoelectric Eq^n

$$\boxed{E_i = E_0 + K.E.}$$

$E_0 = E_i - K.E.$

$E_i = \frac{hc}{\lambda}$

$= \frac{2 \times 10^{-25}}{00 \times 10^{-9}}$

$\Rightarrow E_0 = E_i^\circ - K.E.$

$$\Rightarrow \frac{2 \times 10^{-25}}{300 \times 10^{-9}} - \frac{1.68 \times 10^{5}\ J/mole.}{6.02 \times 10^{23}}$$

$E_0 \Rightarrow$

Unit Coversion

QUANTUM MECHANICAL MODEL OF AN ATOM

⇒ Classical mechanics deals with Laws of Newton in which Old models of atom are based, quantam mechanics deals with Newton Laws & dual nature & Uncertainity Principle.

⇒ Quantam mechanical model of an atom is based on

* Schrodinger Wave Eq^n

$\Rightarrow \left[\hat{H}\psi = \hat{E}\psi \right]$

$\Rightarrow$ $H \Rightarrow$ Hamiltonian operator

$\Rightarrow$ $E \Rightarrow$ Total energy operator

$\Rightarrow$ $x, y, z \Rightarrow$ coordinates

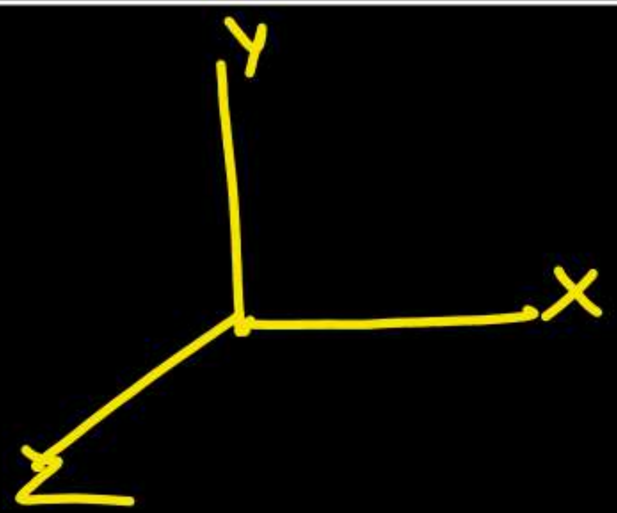
$\Rightarrow$ V = Potential Energy

$\Rightarrow$ ***

$$\boxed{\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} + \frac{8\pi^2 m}{h^2}\underbrace{(E-V)}_{KE}\psi = 0}$$

$\Rightarrow$ E = Total energy

m = mass of $e^{\ominus}$



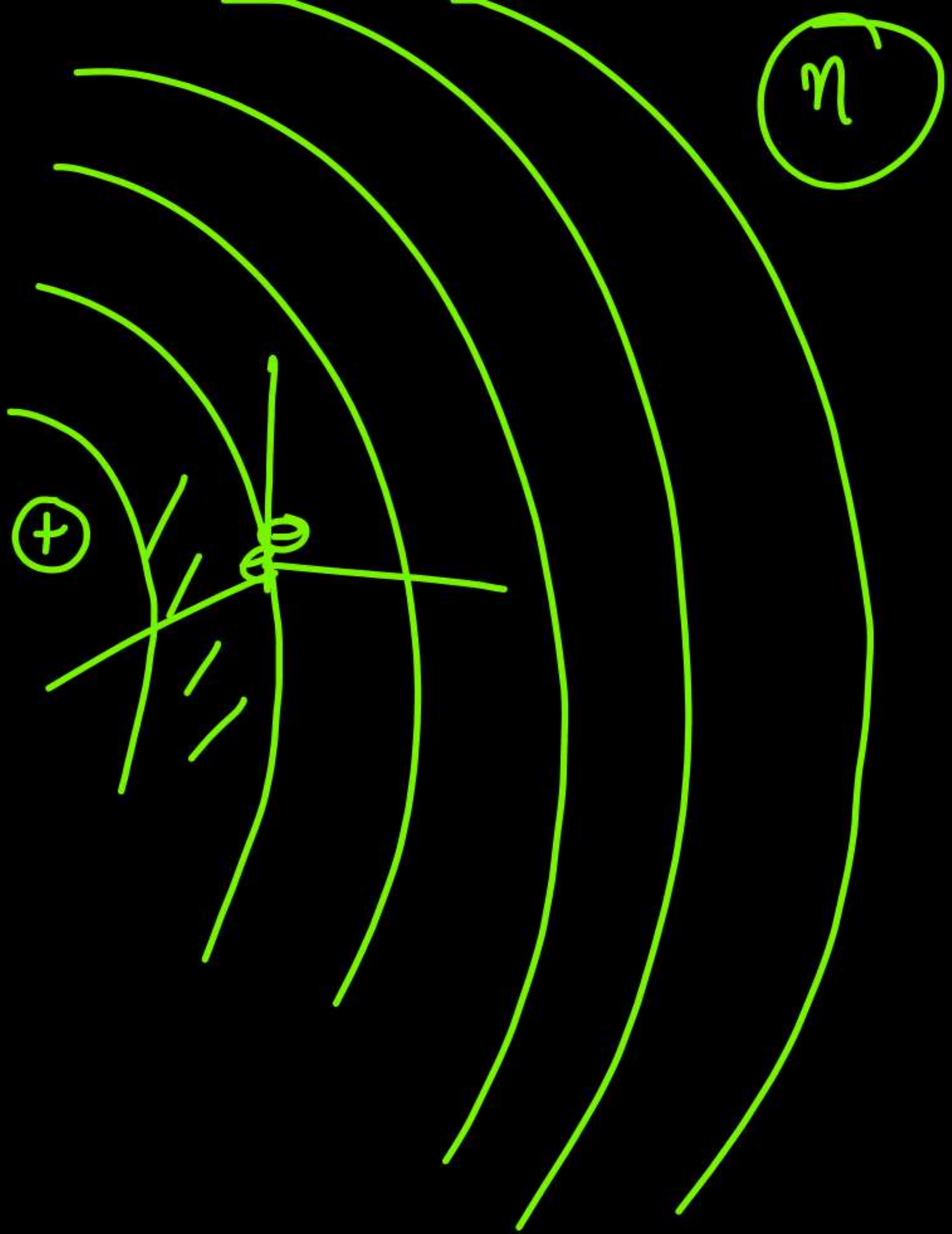
Important Conclusions of Schrodinger Wave Equation

(1) $\Psi \rightarrow$ Eigen function & corresponding values of $\boxed{\text{energies}}$ Known as "EIGEN VALUES"

⇒ (2) Ψ represents orbitals ⇒ $\boxed{\Psi_{n,l,m}}$ $\Psi_{4,1,0}$

⇒ (3) Ψ has no physical significance but $\boxed{\Psi^2}$ gives probability of findin $e^{\ominus}$

(4) 3- Dimensional space around nucleus where probility of finding $e^{\ominus}$ is maximum is Known as $\boxed{\text{ORBITAL.}}$



+
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⇒ Wave function of an e^- (Ψ) is Continous, single value & finite.

QUANTUM NUMBER

⇒ These are the set of four numbers which give us Complete information about an $e^{\ominus}$.

1. PRINCIPLE (n)

AZIMUTHAL ⇒ (l) ⇒ 0 to $n-1$

MAGNETIC (m) ⇒ $-l$ to $+l$

SPIN (s)

① PRINCIPLE QUANTAM NUMBER (n):→

⇒ Proposed by Neils Bohr.

⇒ gives us information about Energy Level or shell or orbit to which an $e^{\ominus}$ belongs.

⇒ $n \neq 0$, $\neq$ -ive, $\neq$ fraction.

n →	1	2	3	4	5
	K	L	M	N	O

$\Rightarrow$ $n \uparrow$, Energy $\uparrow$, Energy difference $\downarrow$

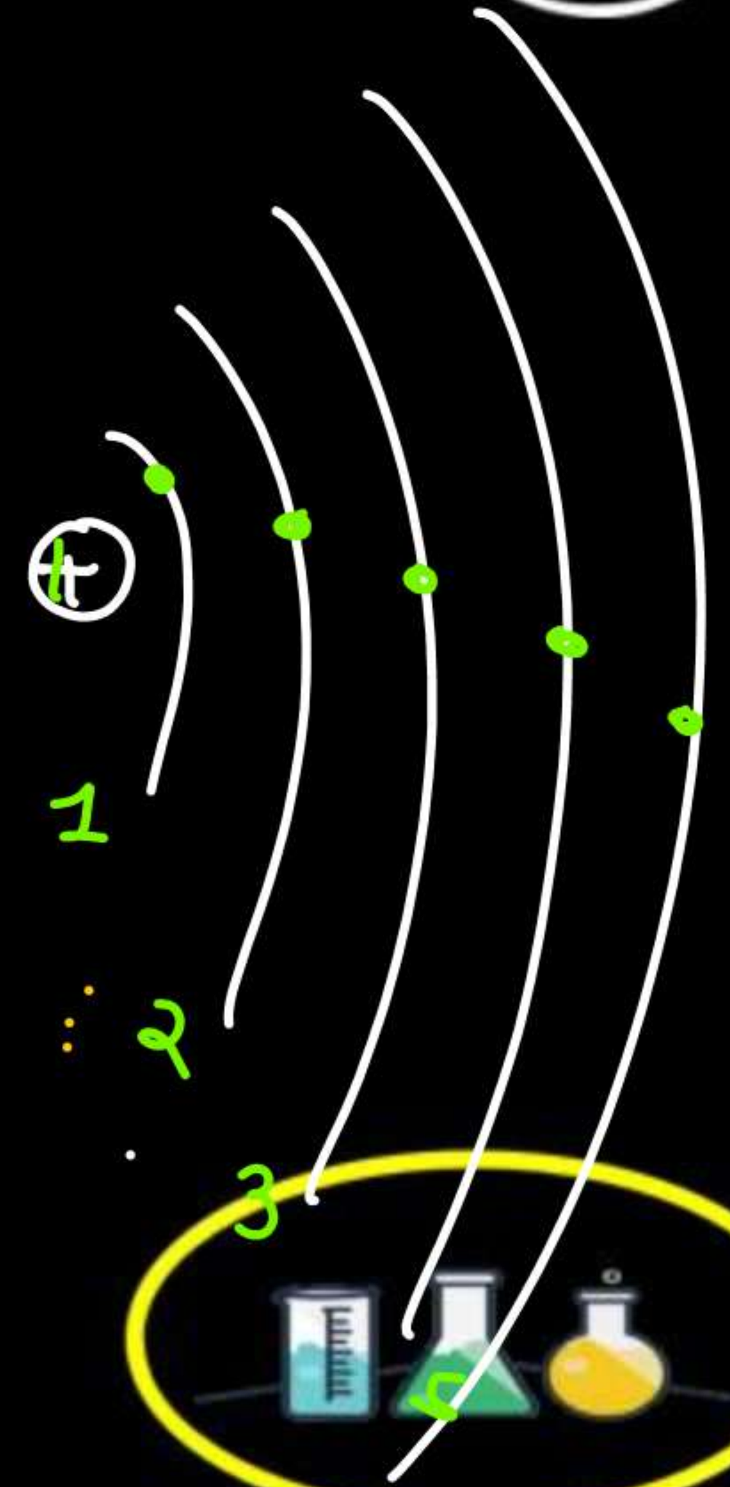
$\Rightarrow$ $n \uparrow$, hold of nucleus on $e^{\ominus}$ $\downarrow$

$\Rightarrow$ $n \uparrow$, SIZE $\uparrow$ $\Rightarrow$ $r = 0.529 \dfrac{n^2}{Z}$

$\Rightarrow$ ORBIT ANGULAR MOMENTUM

$$\boxed{mvr = \frac{nh}{2\pi} \text{ or } n\hbar}$$

$$\hbar = \frac{h}{2\pi}$$



$\Rightarrow$ $n \Rightarrow$ no. of waves made by $e^{\ominus}$

$\Rightarrow$ $n =$ main lines of spectrum.

② AZIMUTHAL QUANTAM NUMBER / SUBSIDIARY QUANTAM NUMBER (l)

⇒ PROPosed by Sommerfeld.

⇒ gives us information about SUBSHELL present within the shell.

$$\boxed{l \not> n}$$

⇒ Values of $l \longrightarrow 0$ to $n-1$

(i)

⇒

l	0	1	2	3	4
Subshell	s	p	d	f	g

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⇒ no. of subshell in a given shell ⇒ n

⇒ given subshell is represented as nl ⇒ 1S

$n = 1$
$l = 0$

⇒ (ii) ENERGY (1) SINGLE e^- SYSTEM or UNIELECTRONIC

(H, He^{+}, Li^{+2}, Be^{+3})

⇒ Energy only depends upon 'n' on 'l'.

⇒ n ↑, Energy ↑, if n is same, Energy is same.

Order $1s < 2s = 2p < 3s = 3p = 3d < 4s = 4p = 4d = 4f$

(2) MULTIELECTRON SYSTEM

⇒ Energy depends upon both 'n' and 'l'

⇒ BOHR BURY RULE → S-1 $n+l$ ↑, Energy ↑

S-2 if $n+l$ is same → n ↑, Energy ↑

⇒ $1s < 2s < 2p < 3s < 3p < 4s < 3d < 4p$

$n+l$ → 1, 2, 3, 3, 4, 4, 5, 5

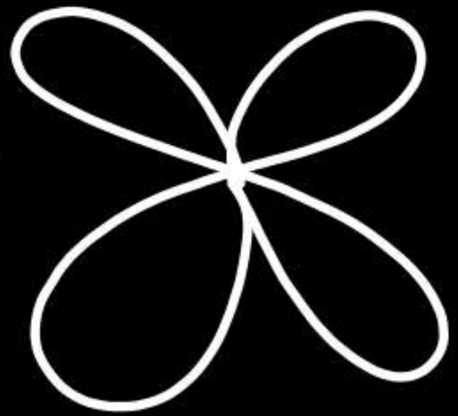
$< 5s < 4d < 5p < 6s < 4f < 5d < 6p < 7s < 5f$

$n+l$ → 5, 6, 6, 6, 7, 7, 7, 7, 8

(iii) SHAPE OF SUBSHELL

$s \rightarrow$ spherical $\rightarrow$ 

$p \rightarrow$ dumbell $\rightarrow$ 

$d \rightarrow$ double dumbell $\rightarrow$ 

$f \rightarrow$ Complicated..

(iv) ORBITAL ANGULAR MOMENTUM

$$\boxed{mvr = \sqrt{l(l+1)}\,\frac{h}{2\pi}}$$

or

$$\boxed{\sqrt{l(l+1)}\,\hbar}$$

- $\hbar = \frac{h}{2\pi}$

Subshell | l | Orbital Angular momentum $\left(\sqrt{l(l+1)}\,\frac{h}{2\pi}\right)$

$s \longrightarrow 0 \Rightarrow 0$

$p \longrightarrow 1 \Rightarrow \sqrt{2}\,\frac{h}{2\pi} \Rightarrow \frac{h}{\sqrt{2}\,\pi} \Rightarrow \sqrt{2}\,\hbar$

$d \longrightarrow 2 \Rightarrow \sqrt{6}\,\frac{h}{2\pi}$ or $\sqrt{6}\,\hbar$

$f \longrightarrow 3$

$\Rightarrow \sqrt{12}\,\frac{h}{2\pi}$ or $\sqrt{12}\,\hbar$

thanks
for watching

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