Atomic Structure :

1. **Charge on e^- :**

$-1.6 \times 10^{-19} C$

Mass of e^- : 9.1×10^{-28} gm.

Specific Charge of e^-

$= \frac{\text{charge}}{\text{mass}} = -1.76 \times 10^{8} \frac{C}{g}$

independent of nature of gas

2. Charge on proton

$= -(\text{Charge on } e^-)$

mass of proton :

1.6×10^{-24}

Specific charge $= 9.58 \times 10^{4}$ C/g

dependent on nature of gas.

3. $1 Fm = 10^{-15} m$

$1 Pm = 10^{-12} m$

$1 A^0 = 10^{-10} m$

$1 nm = 10^{-9} m$

4. Radius of atomic nucleus, is of the order $= 1 Fm$.

5. Increasing order of values of $\frac{\text{charge}}{\text{mass}}$

$= n < \alpha < p < e$

6. $q_\alpha = 2 q_p$

$m_\alpha = 4 m_p$

$m_p = 1840 m_e$

7. $R = R_0 (A)^{1/3}$ Fm.

Radius of Nu — R; 1.2 — R_0; Mass no. — A

8. **Distance of closest approach :** $r = \frac{4kze^2}{m_\alpha v_\alpha^2}$

$K = 9 \times 10^9$.

$m_\alpha = 4 m_p$

α-particle.

for Proton :

$r = \frac{2kze^2}{m_p v_p^2}$

9. ${}_{Z}X^{A}$:

$\boxed{\begin{array}{l} A = \text{Mass no.} \\ = \text{mass proton} + \text{mass neutron} \\ Z = \text{Atomic number} \\ = \text{no. of proton.} \end{array}}$

mass neutron = A - Z

10. Isoelectronic :

> Same no. of electrons.

Isotopes :

> Same atomic no. but diff mass no.

Isobars :

> Same mass no. but diff atomic no.

Isotones :

> Same no. of neutrons.

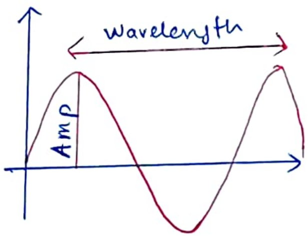
Isosters :

> Same no. of electrons & atoms.

Isodiaphers :

> Same no. of neu-prot

11:



$\boxed{c = \nu\lambda}$ → wave length

Speed $= 3\times10^8$

frequency.

12. EM Spectrum : 400nm 750nm = λ

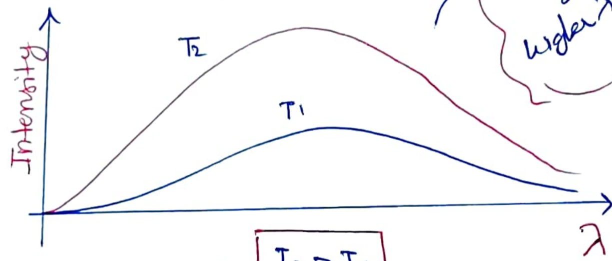
V I B G Y O R

Cosmic Rays, γ Rays, X Rays, U.V Rays, Visible, Infrared, MW, Radio waves

λ↑ ν↓

13. Black Body Radiation :

freq of emitted radiation ↓ higher λ to lower λ



$\boxed{T_2 > T_1}$

14. Photo Electric effect :

- freq ↑, K.E of ejected $e^{\ominus}$ ↑.

Intensity ↑, No. of ejected e^- ↑

- $\boxed{E_{incident} = \phi + KE}$

ϕ = work f^n
= min. energy req. to remove one e^- from metal surface.

$$\boxed{\begin{aligned} h\nu &= h\nu_0 + KE \\ \frac{hc}{\lambda} &= \frac{hc}{\lambda_0} + KE \end{aligned}}$$

ν = freq. of incident light.

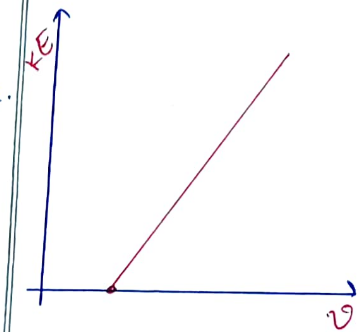
ν_0 = threshold frequency.

λ_0 = threshold wavelength

KE ⟶ maximum Kinetic energy (here)

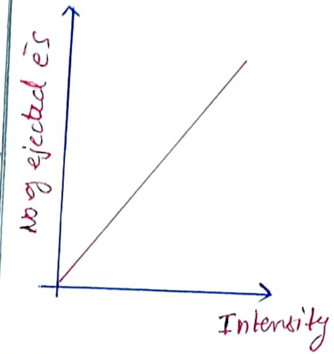
- $\boxed{E_i = \frac{hc}{\lambda} = \frac{12400}{\lambda(A^\circ)} eV}$

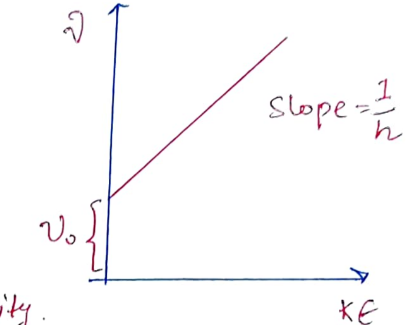
5. Graph:

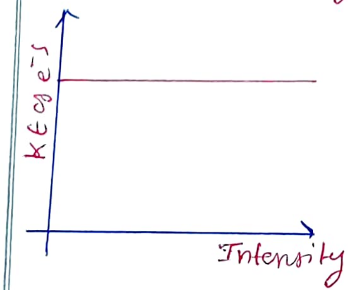


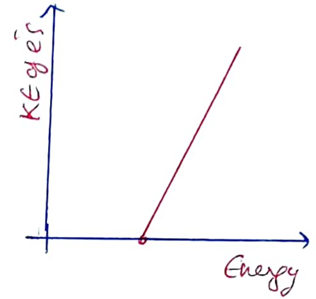
$KE = h\nu - h\nu_0$
$y = mx - c$

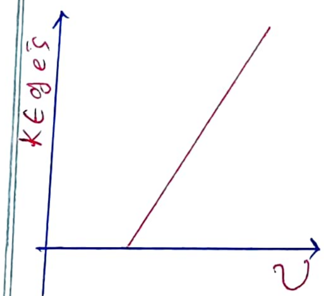
$m = h \quad c = h\nu_0$











Intensity $\propto \frac{1}{r^2}$

r = dist. of source.

Time taken by photo e^- to come out $= 10^{-10}s$

16. $\boxed{K.E = e \times V_s}$

V_s = stopping potential.

17. Plancks quantum Theory:

$$\boxed{E = \frac{nhc}{\lambda} = \frac{n(12400)}{\lambda(A^\circ)}}$$

n = no. of quantums

$h = 6.6 \times 10^{-34}$ J-s

$$\boxed{\frac{hc}{e} = 1240 \text{ nm eV}}$$

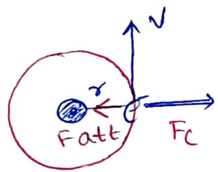
18. Bohr's Theory:

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

n = orbit

|| orbit angular momentum.

#)



$$F_{attraction} = \frac{Kq_1q_2}{r^2} = \frac{K(ze)(e)}{r^2}$$

$$F_{centripetal} = \frac{mv^2}{r}$$

$F_{att} = F_{centripetal}$

$$\frac{kze^2}{r^2} = \frac{mv^2}{r} \rightarrow \boxed{r = \frac{kze^2}{mv^2}}$$

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

derivation imp for JEE

$$mv\left(\frac{kze^2}{mv^2}\right) = \frac{nh}{2\pi}.$$

$$\therefore \boxed{v = \frac{2\pi kze^2}{nh}}$$

$$\boxed{v = 2.18 \times 10^6 \times \frac{Z}{n} \text{ m/s}}.$$

$$m\left(\frac{2\pi kze^2}{nh}\right)r = \frac{nh}{2\pi}.$$

$$\therefore \boxed{r = \frac{n^2h^2}{4\pi^2 mkze^2}}$$

$$\boxed{r = 0.53 \times \frac{n^2}{Z} A^\circ}$$

0.529 ≈

Total Energy = KE + PE

$$= \frac{mv^2}{2} + \frac{kq_1q_2}{r}$$

$$= \frac{1}{2}\left(\frac{kze^2}{r}\right) + \left(\frac{-kze^2}{r}\right)$$

$$= \boxed{\frac{-kze^2}{2r}}$$

$$\therefore \boxed{TE = -KE = \frac{PE}{2}}$$

$$\therefore \boxed{TE = \frac{-2\pi^2 m k^2 z^2 e^4}{n^2 h^2}}$$

$$\boxed{TE = -13.6 \times \frac{Z^2}{n^2} \text{ eV}}$$

$$\boxed{\text{Time period} = \frac{2\pi r}{v} \qquad t \propto \frac{n^3}{Z^2}}$$

$$\boxed{freq = \frac{1}{T} \qquad f \propto \frac{z^2}{n^3}}$$

19. Excitation energy:

$n = n_1 \longrightarrow n = n_2$

$$E.E = E_{n_2} - E_{n_1}$$

$$= -13.6 \times \frac{z^2}{n_2^2} - \left(-13.6 \times \frac{z^2}{n_1^2}\right)$$

$$= 13.6\left(\frac{Z^2}{n_1^2} - \frac{z^2}{n_2^2}\right)$$

$$= \boxed{-13.6 z^2 \times \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)}$$

20. Binding Energy:

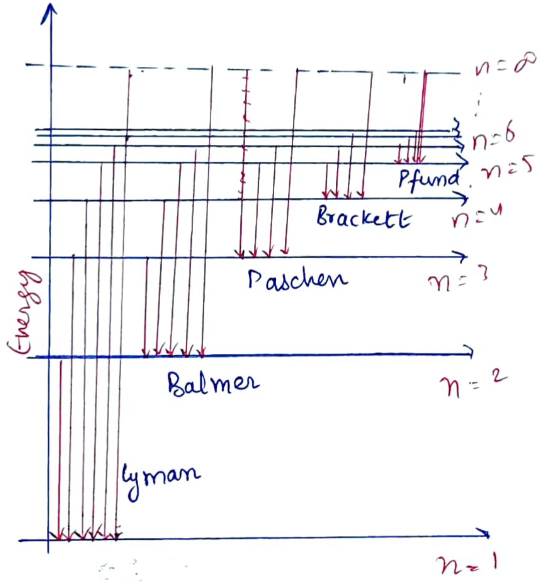
$n \longrightarrow \infty$.

$$BE = E_\infty - E_n$$

$$\therefore \boxed{BE = +13.6 \times \frac{z^2}{n^2}}.$$

21. Hydrogen Spectrum

Lyman	UV
Balmer	Visible
Paschen	near IR
Brackett	IR
Pfund	Far IR
Humphrey	Faar IR



$$\frac{1}{1.097} \approx 0.911$$

Rydberg's formula

$$\boxed{\frac{1}{\lambda} = R_H z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]}$$

n_1 = lower energy level

n_2 = higher energy level

$R_H = 109678 \ cm^{-1}$
$= 1.097 \times 10^7 m^{-1}$

$$\frac{1}{R_H} \simeq 912 A^0$$

★ Series limit = last line]
$n_2 = \infty, n_1 = n$

★ IE: $E_\infty - E_1$

$$(E_n)_{species} = (E_n)_{Hydrogen} \times z^2$$

22. Total no. of Spectral lines $= \frac{(n_2-n_1)(n_2-n_1+1)}{2}$

$= \frac{(\Delta n)(\Delta n+1)}{2}$

23. Total no. of spectral lines in PARTICULAR series

$= n_2 - n'$ → Series no.

Lyman = 1

Balmer = 2

⋮

24. Zeeman Effect : Splitting of spectral lines in Mag. F.

25. Stark Effect : Splitting of spectral lines in Ele. F.

26. DeBroglie hypothesis :

- $\lambda = \frac{h}{mv} = \frac{h}{P}$; $\lambda^2 \alpha \frac{1}{KE}$; $\lambda \alpha \frac{1}{(V-V_0)^{1/2}}$.

$= \frac{h}{\sqrt{2mKE}} = \frac{h}{\sqrt{3mKT}}$ → Boltzman const

$= \frac{h}{\sqrt{2mqv}}$ → q = charge, v = potential.

$= \frac{2\pi\lambda}{n}$, n = no. of wave no.

$= \frac{12.24}{\sqrt{v}} A^0$ (for e^-) $= \sqrt{\frac{150}{v}} A^0$

- uncertainty = Exact value × Accuracy

27. Heisenberg Uncertainty Principle :

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

uncertainity in Pos^n ; in momentum.

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

$\Delta E \times \Delta t = \frac{h}{4\pi}$

Uncertainty in Energy ; in Time.

$\frac{h}{4\pi} = 0.53 \times 10^{-34}$

28. Aufbau Rule:

priority for filling

↓

lower energy → higher energy

1s < 2s < 2p < 3s < 3p ...

Hunds Rule:

→ in degenerated orbitals (equal energy orbitals), pairing starts when each orbital is filled with atleast one electron.

Paulis exclusion:

- No 2 e^{-}s can have all 4 quantum numbers same.

29. Energy Exchange:

Exceptions:

$_{24}Cr \rightarrow [Ar]\ 4s^1\ 3d^5$

$_{29}Cu \rightarrow [Ar]\ 4s^1\ 3d^{10}$.

32.

Orbital Angular Momentum

$$= \sqrt{l(l+1)} \cdot \frac{h}{2\pi}$$

30. Quantum Numbers:

- Principle QN:
  - tells about shell, orbit energy level.
  - denoted by 'n'
- Azimuthal QN:
  - Subshell, Suborbit, Sub Energy level.
  - $l = 0$ to $n-1$

$l=0$	1	2	3
s	p	d	f

- Magnetic QN:
  - orientation.
  - $m = -l$ to $+l$.
- Spin QN:
  - spin.
  - $s = \pm\frac{1}{2}$.

$m = 0$, $m = \pm 1$ → −1, 0, 1

↓

$l = 0$ → s orbital → □ → $m = 0$

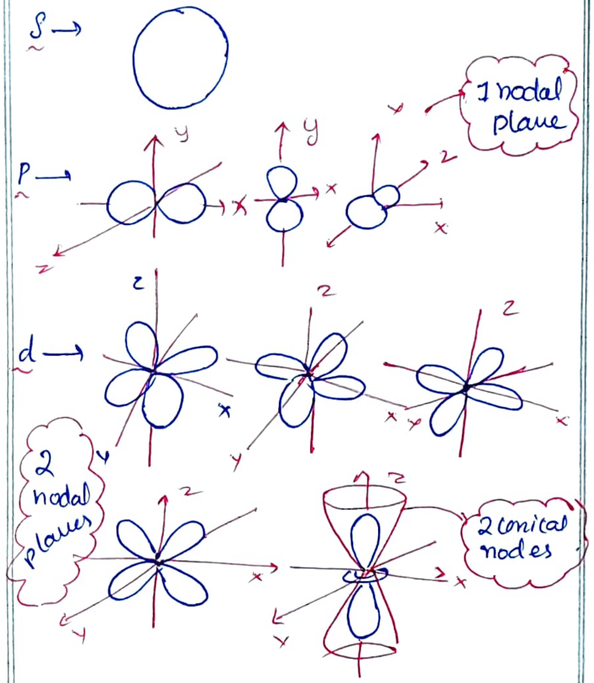
p orb [−1, −1 | 0, 0 | 1, 1] 2e

31.

max no. of orbitals $= n^2 = (2l+1)$

max no. of electrons $= 2n^2 = (2(2l+1))$

33. Shape:



- no. of $\bar{e}$ ejected = $\dfrac{\text{Energy provided}/\text{sec}}{\text{Energy required to eject}}$

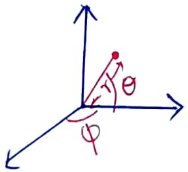
34. Schrodinger Wave Equation:

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

ψ = wave f^n. V = Potential energy

E = Total energy m = mass of $e^{\ominus}$.

Polar coordinates:



- Solving the eq^n polar coordinate, we get equations in ψ as $\psi_1, \psi_2, \psi_3, \ldots$
  → Some of them are meaningful values known as Eigen Values.

- $\psi(r) = \underbrace{\text{Radial part}}_{\text{gives 'r'}} \times \underbrace{\text{Angular part}}_{\text{gives angle}}$.

for s-orbitals:

$\boxed{\psi(r) = \text{radial part}}$

No angular part.

- spin Q.N can't be determined.

- ψ_{210} ψ_{300} ψ_{420}

ψ_{210}: $n=2$, $l=1$, $m=0$ ⇒ $2p_z$

ψ_{300}: $n=3$, $l=0$, $m=0$ ⇒ $3s$

ψ_{420}: $n=4$, $l=2$, $m=0$ ⇒ $4d_{z^2}$

- No Physical significance of ψ, while ψ^2 shows probability of finding $e^{\ominus}$.

- $\psi^2 \rightarrow$ max ⇒ atomic orbital.

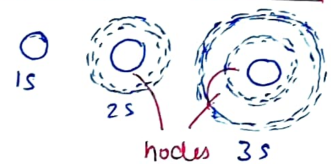
$\psi^2 \rightarrow$ min ⇒ Node.

Space where prob of finding one e^- is Zero.

35. Total no. of nodes $= n-1$

no. of radial nodes $= n-l-1$

$s \rightarrow$



$\boxed{\text{no. of angular nodes} = l}$

$\boxed{\text{nodal plane} = l}$

Ex: $\psi_{2s} = \frac{1}{2\sqrt{2}\pi}\left(\frac{1}{a_0}\right)^{1/2}\left[2 - \frac{r}{a_0}\right]e^{-r/2a_0}$

at $r = r_0$, radial node is formed. Find r_0 in terms of a_0.

Sol: $2s \rightarrow$ No angular part.

radial node

$\psi^2 = \text{min}$, ⇒ ~~const~~ $\psi^2_{2s} = 0$.

$\therefore \left[2 - \frac{r}{a_0}\right] = 0$

$\Rightarrow \boxed{r_0 = 2a_0}$ Ans

Ex: Same as prev, $\psi_{3s} = \frac{1}{a_0\sqrt{3}}\left(\frac{1}{a_0}\right)^{3/2}(6 - 6\sigma + \sigma^2)e^{-\sigma/2}$.

$\sigma = \frac{2Zr}{3a_0}$, what is max radial dist. of node from nucleus?

Sol: node ⇒ $\psi^2_{3s} = 0$

$\Rightarrow (6 - \sigma(6) + \sigma^2) = 0$

$\sigma^2 - 6\sigma + 6 = 0$

$\boxed{\sigma = 3+\sqrt{3}}$ $\sigma = 3-\sqrt{3}$ → max dist at $\sigma(+)$

$\Rightarrow \boxed{r = \frac{3a_0(3+\sqrt{3})}{2Z}}$ Ans

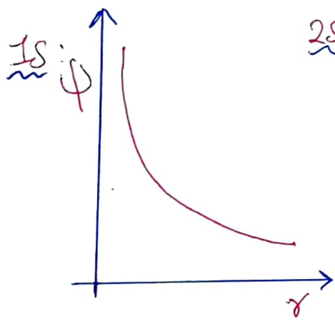
36. Graph:

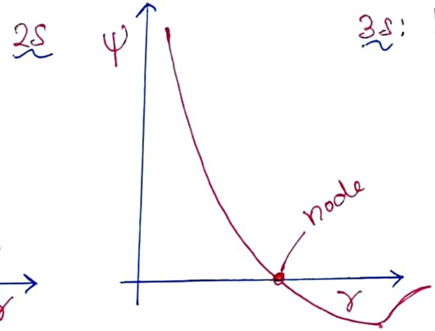
radial nodes:

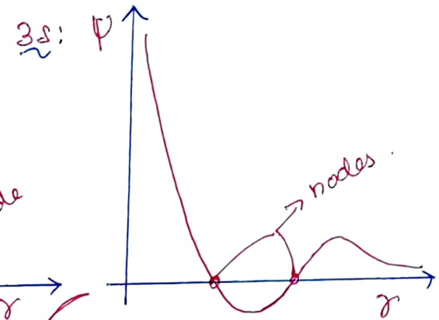
1s → 0

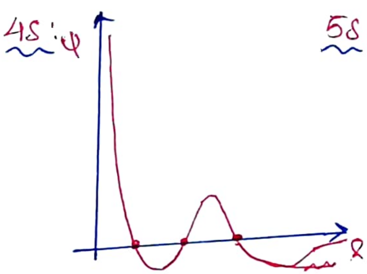
2s → 1

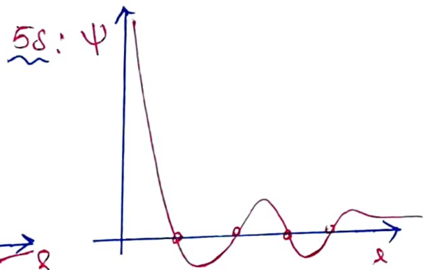
3s → 2



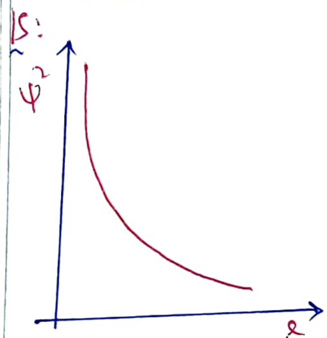


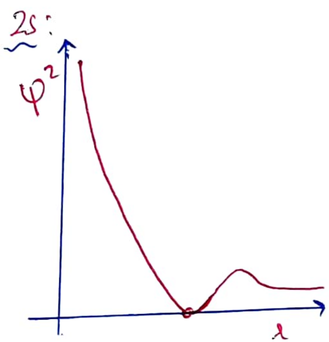


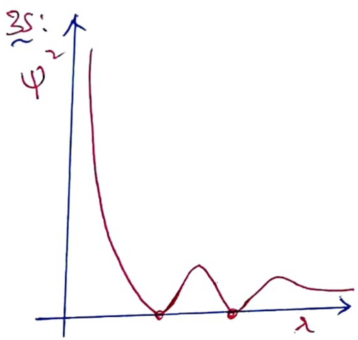


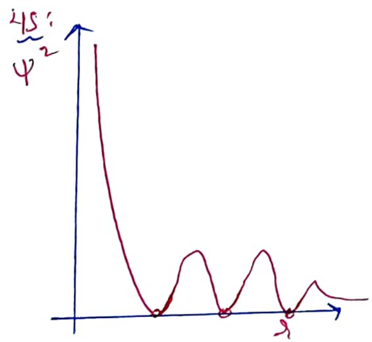


ψ^2 v/s r:





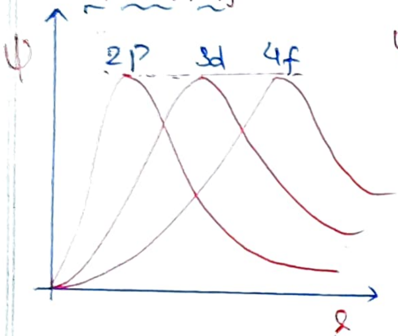




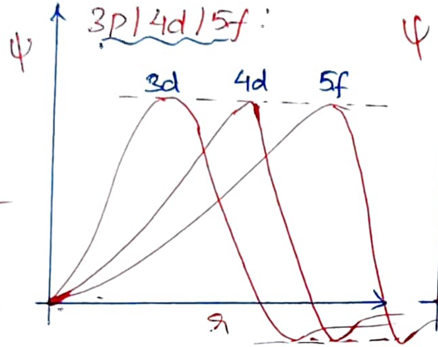
radial nodes: → 3p = 4d = 5f → 1

4p = 5d = 6f → 2 ...

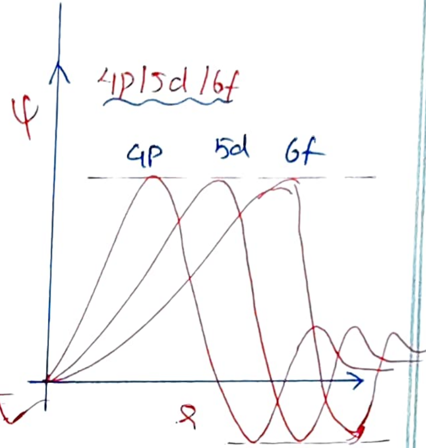
2p | 3d | 4f :



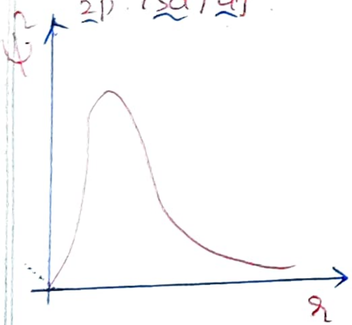
3p | 4d | 5f :

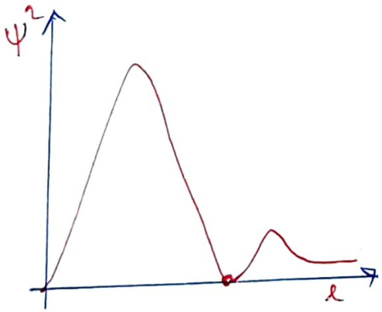


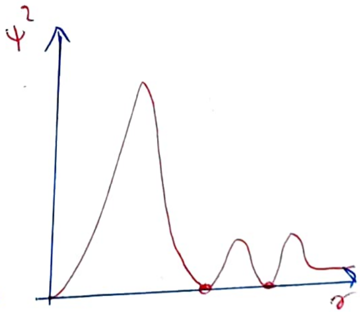
4p | 5d | 6f



2p : | 3d | 4f :



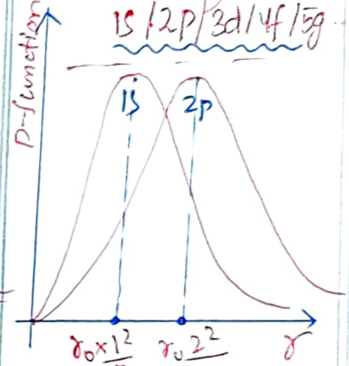




D-function:

radial node = 0

1s | 2p | 3d | 4f | 5g ..



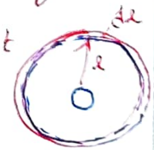
$\boxed{4\pi r^2 \psi^2 dr}$

↓

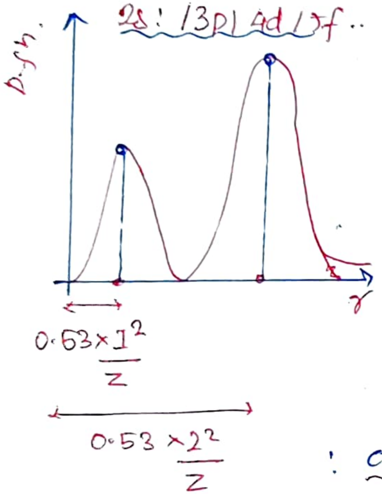
Radial Probablity distribution f^n.

(

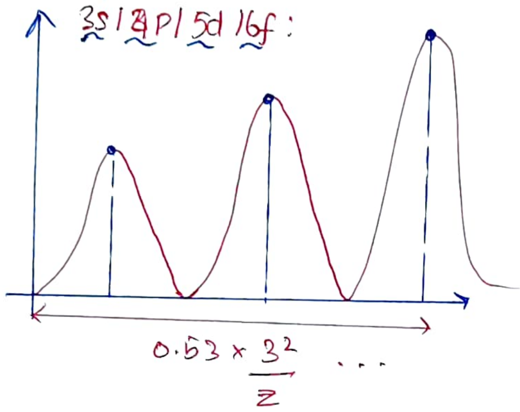
Volume at 'r' distance from centre of dr element taken.



2s: → radial node = 2-0-1 = 1.



→ radial node = 3-0-1 = 2



: d-function :

- Energy Of Subshell $\propto (n+l)$
  If $(n+l)$ is same $\propto n$.

- Magnetic moment $= \sqrt{n(n+2)}$
  n = unpaired $e^{\ominus}s$.

- Spin Multiplicity $= 2S+1$
  $S = \pm \frac{n}{2}$ → no. of unpaired $e^{\ominus}$

- Energy For H / 1e⁻ : $1s < 2s = 2p < 3s = 3p = 3d < 4s = 4p = 4d = 4f < \ldots$

  Energy for others ($>1e^-$) : $1s < 2s < 2p < 3s < 3p < 4s < 3d \ldots$
  (n+l) rule

- n_p (at 1 sec) $= \frac{N_0}{T} = \frac{P_0}{h\nu}$
  → no. of photons per sec ; (T = 1)
  P_0 = Power

degeneracy = no. of degenerate orbitals → for s = 1, d = 5, p = 3, f = 7