Chapter-2

ATOMIC STRUCTURE

Part I

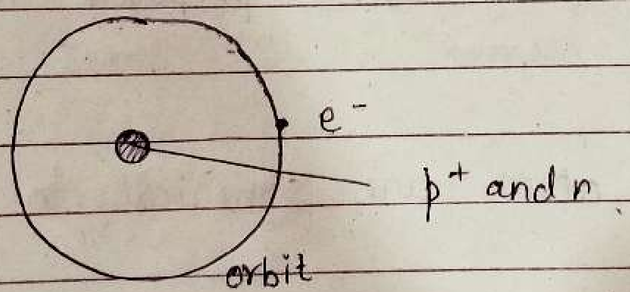
History of chemistry

In this chapter, we study about the world of atom

I. John Dalton ⟶ Dalton's Atomic theory

II. J.J Thomson ⟶ proton

III



(*) Dalton's Atomic Theory [1808]

i. "A - Tom" John dalton give this term, The word atom derived from latin word 'atom' that is undivisible

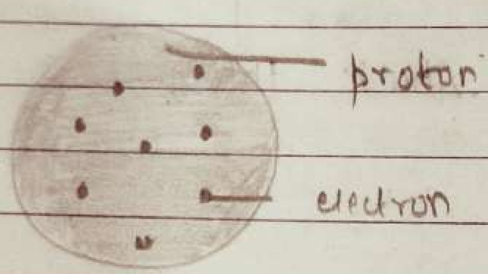
I All the matter are made up of atom

II Atoms are neither be created nor destroyed.

IV In any chemical reaction, complete atom participate.

V. Each and every atom have same physical and chemical properties (different atom have different properties)

* J.J Thomson 1905
plum pudding model or watermelon model



I Thomson was first scientist who proposed the detail model of atom

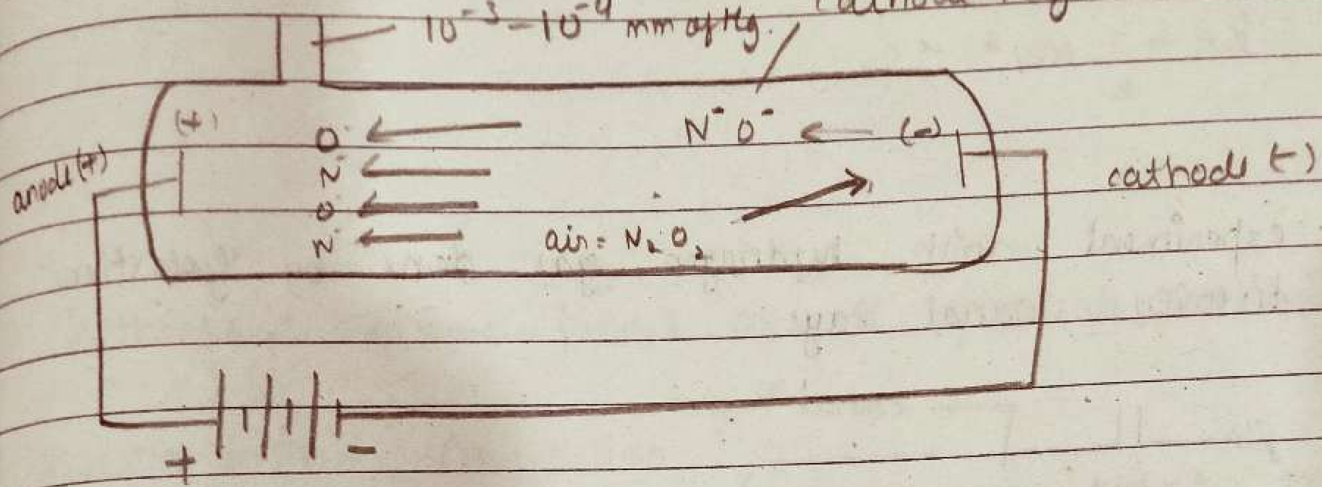
II According to him, atom are spherical in shape

III Proton are just like red part of watermelon and electron are non-uniformly ambedded in atom just like seed of watermelon.

Drawback:
proton ~~are~~ are not uniformly distribute in atom.
According to him, it static model

+ve particle

Experiment of J.S Thomson
(Discovery of e^-)



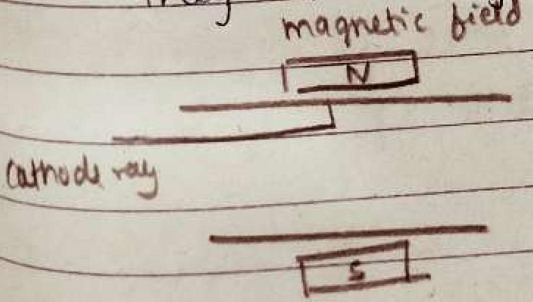
J.J Thomson used discharge tube with very low pressure $10^{-3} - 10^{-4}$ mm of Hg and high voltage (10^4 volt)
Through this setup, J.J Thomson discovered ~~this~~ cathode rays

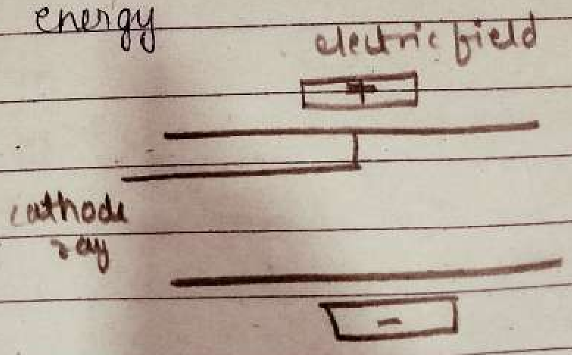
Properties of cathode rays

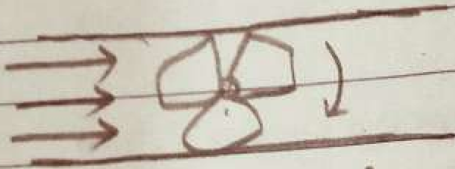
→ cathode rays are negatively charged e^- particle

→ They deflect in positive or north pole

→ They have high kinetic energy

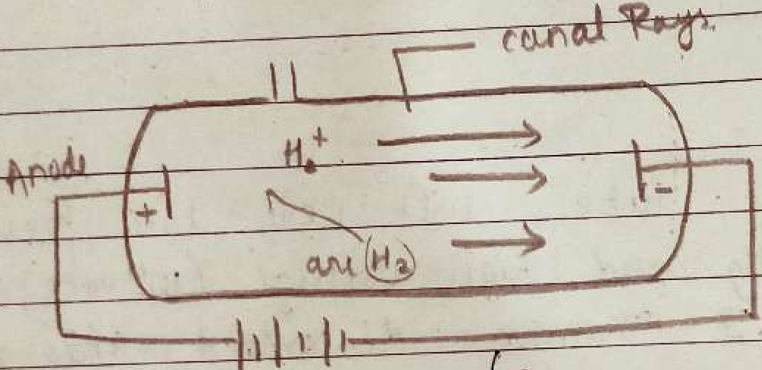






$KE = \frac{1}{2} mv^2$

Same experiment with hydrogen gas done by Goldstiene and discover canal rays



James chadwick. (Discovery of neutron)

$_{2}\alpha^{4} + {}_{5}B^{11} \longrightarrow {}_{7}N^{14} + {}_{0}n^{1}$

Q. Rutherford Atomic Model or α - particle scattering experiment

Observation and Conclusion

i. 99.9 % alpha particles go straight. That's means 99 % space are empty

ii. 0.01 % alpha particles scattered from their path. That is center are +vely charge and α - particle is also +vely charge so they repel each other

iii. Nucleus of the atom are very very small and complete mass of atom are in the nucleus because 1 in 20,000 follows the same path of the α - particle i.e deflection 180°

Size of atom — 10^{-10} m
Size of nucleus — 10^{-15} m

Representation of Atom

$$\text{no. of } p^+ + \text{no. of } n \text{ (Atomic mass)} \leftarrow A \quad {}^{A}_{Z}X^{i}_{N} \quad i \leftarrow \text{ionic form}, \quad N \leftarrow \text{No. of atoms}$$

Atomic no. ← Z

→ no. of e^- in ground state = ne^-
→ no. of p^+ = np

Sub-atomic particles

particles	mass	Charge	Discovered By	Represented
electron e^-	9.1×10^{-31} kg -28 g	-1.6×10^{-19} C	J.J Thomson	Z
proton p^+	1.677×10^{-27} kg 24 g	$+1.6 \times 10^{-19}$ C	Goldstein	Z
neutron n^0	1.678×10^{-27}	0	J. Chadwick	A − Z

	e	p	n
${}_{8}O^{16}$	8	8	8
${}_{7}N^{14}$	7	7	7
${}_{26}Fe^{56}$	26	26	30

* Isotopes

→ same Z different A
→ no. of neutron different

	e	p	n
^1_1H	1	1	0
	Z		
^2_1H	1	1	1
^3_1H	1	1	2

mass no. different: neutron

* Isobars

→ Z different but same A
→ n + p are same

	e	p	n	n + p
$^{14}_6C$	6	6	8	14
$^{14}_7N$	7	7	7	14

same

Que If mass of neutron is double and the mass of e^- is half, so what is the new mass of $^{12}_{6}C$ and also find percentage increased?

		e	p	n
old	$_6C^{12}$	6	6	6
new	Y	3	6	12

$^{18}_{6}C$

$$\% \text{ of } C = \frac{f-i}{i} \times 100$$

$$= \frac{18-12}{12} \times 100$$

$$= \frac{\cancel{6}^{1}}{\cancel{12}_{2}} \times \cancel{100}\ 50$$

$$= 50\%$$

Que If the mass of neutron is double and mass of p^+ is halfed and mass of e^- is also double, then find out the atomic weight and % increase in $^{12}_{6}C$?

		e	p	n
old	$^{12}_{6}C$	6	6	6
new	$^{15}_{3}Y$	12	3	12

$$\% \text{ of } C = \frac{f-i}{i} \times 100$$

$$= \frac{15-12}{12} \times 100$$

$$= 25\%$$

Que If no. of protons in X^{-2} is 16 then, no. of e^- X^{2+} will be?

	e	p	n
X	16	16	
	+2		
X^{-2}	18		
	16 - 2		
X^{+2}	$14e^-$		

Que Assume the atomic weight of $^{12}_{6}C$ is 150 unit then, according to this assumption, the weight of $^{16}_{8}O$ will be?

$12\,u = 150$ unit

$1\,u = \frac{150}{12}$ unit

$^{16}O \rightarrow 16\,u = \frac{150}{12} \times 16$

$= 200$ units

Que Average Atomic mas

$^{A_1}X \rightarrow a\ \%$

$^{A_2}X \rightarrow b\ \%$

$^{A_3}X \rightarrow c\ \%$

Avg atomic mass $= \frac{A_1 \times a + A^2 \times b + A^3 \times c}{100}$

Que A element have 3 isotope 11, 12 and 13 and its occurance % are 85 %, 10 %, 15 % respective find its avg atomic mass

$X^{11} = 85\%$

$X^{12} = 10\%$

$X^{13} = 5\%$

Av at mass $= \dfrac{11 \times 85 + 12 \times 10 + 13 \times 5}{100}$

$= \dfrac{1120}{100}$

$= 11.20u$

Que Averge atomic mass of element M is 51.7 if its isotope are ^{50}M and ^{52}M then, what is % of M^{50} in atmosphere?

$^{50}M \longrightarrow x\%$

$^{52}M \longrightarrow 100 - x\%$

$51.7 = \dfrac{50 \times x + 52 \times 100 - x}{100}$

$5170 = 50x + 5200 - 52x$

$5170 - 5200 = 50x - 52x$

$\cancel{-}30 = \cancel{-}2x$

$\dfrac{30}{2} = x$

$\boxed{15 = x}$

$100 - 15 = 85\%$

DPP-01

1. ~~new~~ e p n

$_8O^{16}$ 8 8 8

$^{20}_{16}X$ 16 16 4

$\% = \frac{f-i}{i} \times 100$

$= \frac{20-16}{16} \times 100$

$= \frac{\cancel{4}^{1}}{\cancel{16}_{4}} \times \cancel{100}^{25}$

$= 25\%$

		p	e	n
2. ~~no cat~~	Y	18	18	
	Y^{-2}	20		
	y^{+3}	15		

	e⁻	p	n
3. $^{16}_{8}O$ =	~~clear~~ 8	8	8

	e	p	n
$^{27}_{13}Al$	13	13	14

6. p e n

a b c

n	e	p
14	13	13

$\frac{24}{31}$ 10 - 100

p n e

$^{231}_{89}Y$ 89 142 89

8. 10 , $\frac{3+8}{10}$, $\frac{7+3}{10}$

12 , $\frac{1+17}{18}$, 12 + 5

18 1 + 17 , $\frac{12+5+1}{18}$ $\frac{PH_3}{15+3}$

10. $\begin{array}{r} 76 \\ 32 \\ \hline 44 \end{array}$ $\begin{array}{r} 77 \\ 33 \\ \hline 44 \end{array}$

10. 10 , $\frac{3+8-1}{10}$, $\frac{\cancel{7}+4-1}{10}$

~~16+6 = e 19~~

11. $\begin{array}{r} 13 \\ -6 \\ \hline 7 \end{array}$ $\begin{array}{r} 17 \\ -8 \\ \hline 9 \end{array}$ 17 + 8 ..

p e n n-t

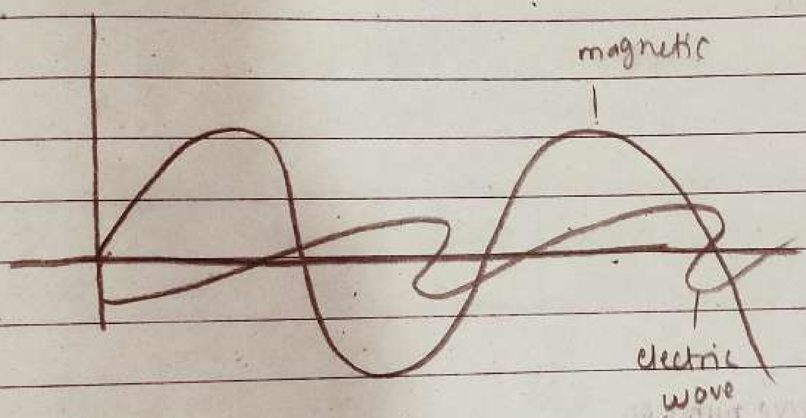
$^{13}_{6}C$ $^{17}_{8}O$ 6 6

Quantum Physics / Mechanism

In this topic, we studied about electromagnetic wave of sunlight. Light are wave in nature

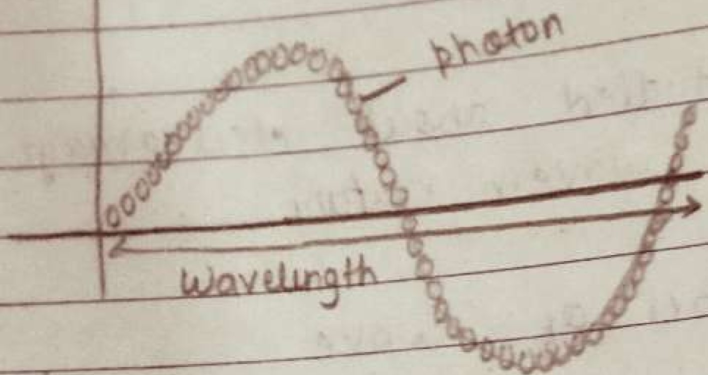
In this wave, 2 types of wave
→ electric
→ magnetic
and both are called E.M waves / Electro magnetic waves

- In any light there are small bundles of energy packets is called photon



- In this wave,

⇒ Wavelength : The distance covered by one cycle is called wavelength.
Its unit are m (S.I), cm, picometer (10^{-12} m), nanometer (10^{-9} m); A° (10^{-10})



Nu (ν)

Frequency : No. of turns/cycle per second.

$$\nu = \frac{\text{no. of cycle}}{\text{sec}}$$

$$= \frac{1}{\text{sec}}$$

$$= \text{sec}^{-1}$$

$$\boxed{\nu = \text{Hertz}}$$

Wave number = That is the inverse of wavelength

$$\frac{1}{\lambda} = \bar{\nu} = \text{wave number}$$

m^{-1}

Time period : It is inverse of frequency.

$$\boxed{\frac{1}{\nu} = T}$$

(*) Electromagnetic spectrum

$E \propto \nu$

$E \propto \frac{1}{\lambda}$ 3000 A° 7000 A°

300 nm 700 nm

Cosmic wave	γ rays	X ray	U.V rays	Visible	Infra rays	micro wave	communication wave	Radio wave

$\lambda\downarrow$

$\nu\uparrow$ $E\uparrow$

V I B G Y O R

$\lambda\uparrow$ $\nu\downarrow$

$E\downarrow$

→ Each and every photon carry bundle of energy packets

Energy of photon = $E \propto \nu$

$$\boxed{E = h\nu}$$

J, sec^{-1}

plancks constant (6.63×10^{-34} Js)

$\lambda \propto \frac{1}{\nu}$

$\boxed{\nu = \frac{c}{\lambda}} \longrightarrow$ velocity of light $= 3 \times 10^8$ m/sec

$\boxed{E = \frac{hc}{\lambda}} \Rightarrow \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{\lambda} = \frac{2 \times 10^{-25}}{\lambda}$ J

$1\ eV = 1.6 \times 10^{-19}$ J

$E = \frac{hc}{\lambda \times e}\ eV = \frac{1.25 \times 10^{-6}}{\lambda}\ eV$

Ques1. AIR broadcast a radio frequency of 1368 KHz. Calculate the wave length of this frequency?

$\nu = 1368 \times 10^3$ Hz

$\lambda = \frac{c}{\nu}$

$= \frac{3 \times 10^8}{1368 \times 10^3}$

$\boxed{\lambda = 219.29\ m}$

Que 2 Yellow $\lambda = 5800 A^\circ$, what is the wave length?

$\lambda = 5800 \times 10^{-10}$

$\bar{\nu} = \frac{1}{\lambda}$

$= \frac{1}{5800 \times 10^{-10}}$

$= \frac{10^{10}}{5800}$

$= \frac{10000}{5800} \times 10^{6}$

$= 1.76 \times 10^{6} m^{-1}$

$= 1.72 \times 10^{4} cm^{-1}$

Que 3 Calculate the energy of photon which wave length is 5.862×10^{-16} n

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

$E = \frac{2 \times 10^{-25}}{\lambda}$

$E = \frac{2 \times 10^{25}}{5.862 \times 10^{-16}} = \frac{20 \times 10^{-26}}{5.862 \times 10^{-16}}$

$E = \boxed{3.38 \times 10^{-10}}$

Que Calculate the wavelength which has energy of 2ev

$E = 2ev$

$$E = \frac{hc}{\lambda e} \; ev$$

$$\lambda = \frac{1.25 \times 10^{-6}}{2} \; m$$

$$= .625 \times 10^{-6}$$

$$\boxed{\lambda = 625 \, nm}$$

* No. of photon
Energy = ?

$$\boxed{E = \frac{nhc}{\lambda}}$$

DPP-03

2. $\nu = \frac{c}{\lambda}$

$\nu = \frac{3\times10^{8}}{6500\times10^{-16}} = \frac{30000}{6500}\times10^{4+10} = 4.61\times10^{14}\,s^{-1}$

3. $E = \frac{hc}{\lambda e}$

$\lambda = \frac{1.25\times10^{-6}}{5} = 0.25\times10^{-6} = 2.5\times10^{-7}\,m$

4. $E = \frac{h\times c}{\lambda e}$

$= \frac{1.25\times10^{-6}}{5520\times10^{-10}}$

$= 0.00022644\times10^{-4}$

$= 2.24$ eV

5. $E = \frac{nhc}{\lambda}$

$= \frac{1.25\times10^{-6}}{5000\times10^{-10}}$

$= 0.00025\times10^{-4}$

$= 2.5$ eV

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

$= \frac{1J\times5000\times10^{-10}}{2\times10^{-25}}$

$= 2.5\times10^{18}$

DPP-02

1. $\lambda = \frac{c}{\nu}$

$= \frac{3 \times 10^8}{1260 \times 103}$

$= 238.1 \text{ m}$

2. $\bar{\nu} = \frac{1}{\lambda}$

$= \frac{1}{4600 \times 10^{-10}}$

$= \frac{10000 \times 10^6}{4600}$

$= 2.1739 \times 10^6 \text{ m}$

3. $\lambda_1 = \frac{c}{\nu_1}$ $\qquad \nu_1 = \frac{c}{\lambda_1}$ $\qquad = \frac{\nu_1}{\nu_2} = \frac{\lambda_2}{\lambda_1}$

$= \qquad \nu_2 = \frac{c}{\lambda_2}$

$\Rightarrow \frac{\lambda_1}{\lambda_2} = \frac{\nu_2}{\nu} = \frac{2025}{1350} = \frac{81}{54} = \frac{3}{2}$

Que. The upper stratosphere consisting of the ozone layer protects us from the sun's radiation that falls in the wavelength region of: (Jee Main 2019)

(a) 600 - 750 nm (b) 0.8 - 1.5 nm (c) 400 - 550 nm
(d) 200 - 315 nm

Que. The energy of one mole of photon of radiation of wavelength 300 nm is (JEE Main P-9 2022)

[given $h = 6.63 \times 10^{-34}$ Js, $N_A = 6.02 \times 10^{23}\ mol^{-1}$]

Sol. given $\underbrace{n}_{\text{no. of photon}} = \underbrace{6.02 \times 10^{23}}_{\text{1 mole}}$

$\lambda = 300\,nm$
$= 300 \times 10^{-9}\,m$

$$E = \frac{nhc}{\lambda} = \frac{6.02 \times 10^{23} \times 2 \times 10^{-25}}{300 \times 10^{-9}} = \frac{\cancel{12}^{4} \times 10^{-25+23+7}}{\cancel{3}}$$
$= 4 \times 10^5$
$= 400 \times 10^3$
$= \boxed{400\,kJ}$

(a) 235 kJ mol^{-1}
(b) 325 kJ mol^{-1}
(c) 399 kJ mol^{-1}
(d) 435 kJ mol^{-1}

Que. The value of planks constant is 6.63×10^{34} Js. The speed of light is 3×10^{17} nm s^{-1}. Which value is closest to the wavelength in nanometer of a quantum of light with frequency of $6 \times 10^{15} s^{-1}$? (Neet 2013)

(a) 10 (b) 25 (c) 50 (d) 75

$\lambda = \frac{c}{\nu}$

$= \frac{3 \times 10^8}{6 \times 10^{15}}$

$= \frac{30}{6} \times 10^{7-15}$

$= 5 \times 10^{-8}$

$= 50 \times 10^{-9}$ nm

Que Calculate the energy in joule corresponding to light of wavelength 45 nm (Plank constant = h = 6.63×10^{-34} Js, speed $c = 3 \times 10^8$ ms^{-1}) (AIPMT 2014)

(a) 6.67×10^{15} (b) 6.67×10^{11} (c) 4.42×10^{-15} (d) 4.42×10^{-18}

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

$E = \frac{4 \times 10^{-25}}{45 \times 10^{-19}}$

$= \frac{200 \times}{45} 10^{-25+9}$

$= 4.5 \times 10^{-18}$ J.

Que A particular station of All India Radio, New Delhi broad cast on a frequency of 1368 K H_2. The wavelength of electromagnetic radiation emitted by the transmitter is: (Neet 2021)

(a) 2.193 m (b) 219.2 m (c) 2192 m (d) 2192 cm

$\nu = 1368 \times 10^3$ Hz

$\lambda = \frac{c}{\nu}$

$= \frac{3 \times 10^8}{1368 \times 10^3}$

$= \frac{3000 \times 10^{5-3}}{1368}$

$= 2.2 \times 10^2$

$= 220$ m

Que The energies E_1 and E_2 of two radiations are 25 ev and 50 ev respectively. The relation btw their wavelength i.e λ_1 and λ_2 will be (AIPMT 2011)

(a) $\lambda_1 = 2\lambda_2$ (b) $\lambda_1 = 4\lambda_2$ (c) $\lambda_1 = \frac{1}{2}\lambda_2$ (d) $\lambda_1 = \lambda_2$

$E_1 = \frac{hc}{e\lambda} = 25\,ev$ $E_2 = \frac{hc}{e\lambda_2} = 50\,e$

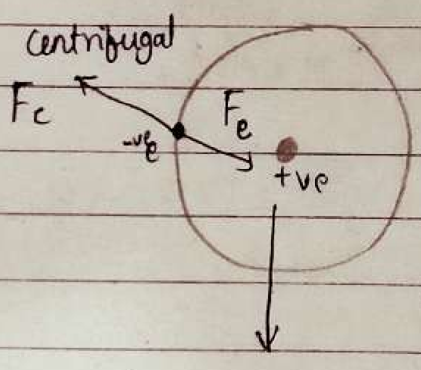
$\frac{E_1}{E_2} = \frac{\lambda_2}{\lambda_1}$

$\frac{\cancel{25}^{1}\,ev}{\cancel{50}_{2}\,ev} = \frac{\lambda_2}{\lambda_1}$

$\boxed{\lambda_1 = 2\lambda_2}$

⊛. Mathametical expression of Rutherford

experiment ⟶ model ⟶ solar system



$e^- = -1.6\times10^{-19}$
$p^+ = +1.6\times10^{-19}$
$-e = e$
$\downarrow \quad \downarrow$
$e^- \quad p^+$

no. of proton = +ve = Z
charge in proton = e
charge in e^- = -e

Force of centrifugal + Force of electrostatic = 0

$\boxed{k = \text{constant}}$

$$F_e = \frac{k\, q_1 q_2}{r^2}$$

q_1 = force $e^- = -e$

q_2 = for proton = e

$$F_e = \frac{k\, \overset{q_1}{e} \times \overset{q_2}{Ze}}{r^2}$$

$$F_e = -kZe^2 \quad \text{—— (i)}$$

$$F_e = \frac{mv^2}{r^2} \quad \text{—— (ii)}$$

$$F_e + F_e = 0$$

$$-\frac{kZe^2}{r^2} + \frac{mv^2}{r} = 0$$

$$\frac{mv^2}{\cancel{r}} = \frac{kZe^2}{r^{\cancel{2}}}$$

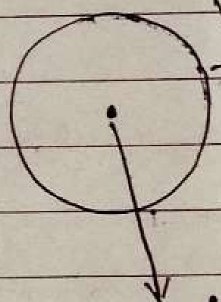
$$\boxed{r = \frac{kZe^2}{mv^2}} \quad \text{—— (I)}$$

$$\boxed{v = \sqrt{\frac{kZe^2}{mr}}} \quad \text{—— II}$$

Size of Atom / Nucleus

Atom size = $\mathring{A}$ range
$\downarrow$
$10^{-10} m$

Nucleus size = fermi range (smallest unit of length)
$\downarrow$
$10^{-15} m$.



Vol^m of sphere
$\frac{4}{3}\pi r^3$
$\Downarrow$
$(10^{-10})^3 = 10^{-30} \longrightarrow$ range of Atom

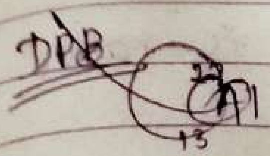
$\frac{4}{3}\pi r^3$
$\downarrow$
$(10^{-15})^3$
10^{-45} —— range of nucleus.

Difference of nucleus and atom is 10^{15} //.

$$\boxed{r = 1.33 \times 10^{-15} \times A^{1/3}\ m}$$

↓ radius of nucleus

↓ Atomic mass



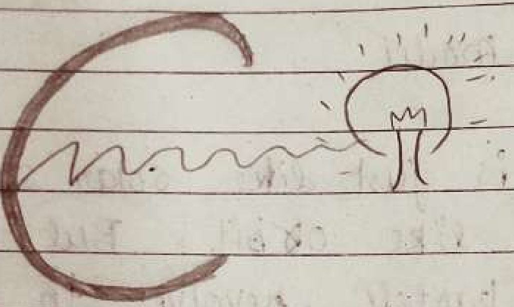
Demerits of Rutherford model

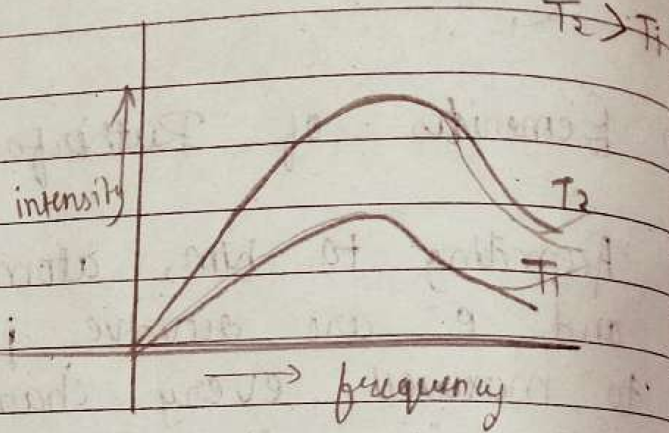
(i) According to him, atom is just like solar system and e^- are revolve just like orbit. But according to maxwell, every charge particle revolves in any orbit. it emit energy in the form of radiation and this energy decreases and they come closer to nucleus and follow spiral path and merge in the nucleus.

(ii) The absorption spectrum of electron are discontinue. But, according to him spectrum must be continues. because they continuely emit energy.

(*) Black body Radiation

(i) The ideal body which emit and absorb radiation of all frequency is called a black body and a radiation emitted by such a body that is called Black body radiation.





(*) P.E.C (Photoelectric effect)

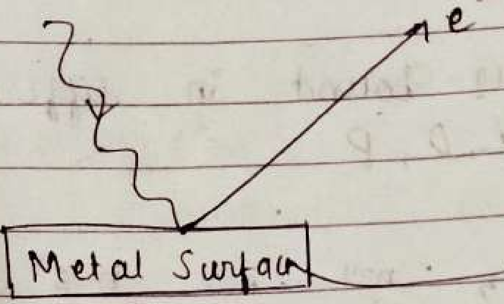
Ejection of an electron from the surface of metal in the absorption of correct wavelength of photon is called photo electric effect

Energy of ~~electron~~ photon are always greater than one function of metal surface.

Work function : This is the property of meta, every metal have different work Fuction it is difined as minimum energy required to remove an e^- from its outermost surface of metal.

Threshold frequency : Minimum frequency to remove an e^- from its outermost surface of metal.

Einsteine Photo electric effect



work function ϕ (औकात)

solar pannels

Einstein PEE formula

$\phi < E$

$\nu > \nu_0$

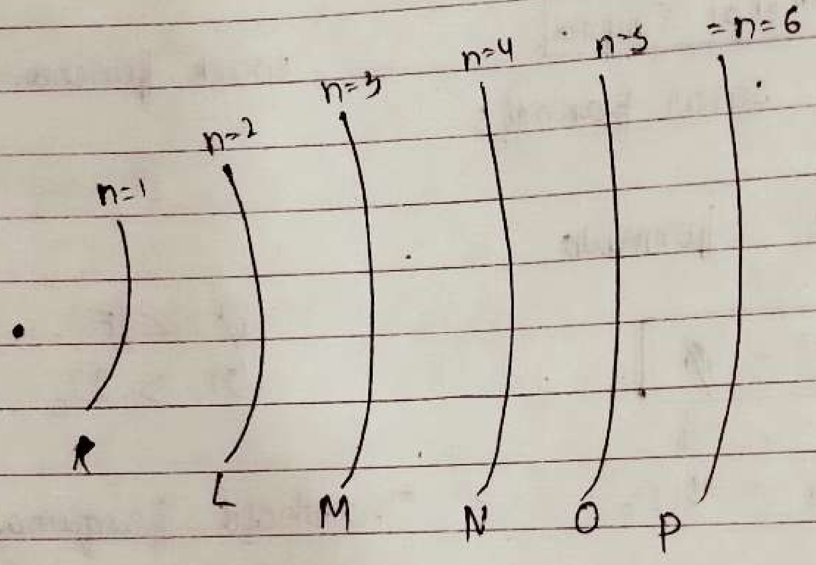
$$\boxed{KE = E - \phi}$$

$\frac{1}{2} mv^2 = h\nu \rightarrow h\nu_0 \longrightarrow$ Threshold frequency

Bohr's Atomic Theory

Postulate 1: Atoms are spherical in shape
→ centre of atom are called Nucleus
→ centre of nucleus is + charged
→ Electrons are revolving around the nucleus just like planetary system.

Postulate 2: Electron are bound in different type of shell called K, L, M, N, O, P



(iii) Bohr's atomic model is only applicable for

Mono electronic species

$_{1}H^{0}$

$_{2}He^{+}$

$_{3}Li^{2+}$

$_{4}Be^{+3}$

$_{11}Na^{+10}$

Postulate 3: According to Bohr's model, every orbital have particular angular momentum.

(i) angular momentum = $mvr = \frac{nh}{2\pi}$

(ii) radius

$$r_n = \frac{n^2h^2}{4\pi^2 kZe^2 m} = 0.529 \times \frac{n^2}{Z} \ A^\circ$$

$$\frac{r_1}{r_2} = \frac{n_1^2 Z_2}{n_2^2 + Z_1}$$

(iii) velocity

$$v_n = \frac{2\pi kZe^2}{nh} = 2.188 \times 10^6 \times \frac{Z}{n} \ m/s$$

$$\frac{v_1}{v_2} = \frac{Z_1 \times n_2}{Z_2 \times n_1}$$

(iv) Energy = $\frac{4\pi^2 k^2 z^2 e^4 m}{n^2 h^2} = -13.6 \times \frac{Z^2}{n^2}$ ev/atom

$$= -1312 \times \frac{Z^2}{n^2} \ kJ/mole$$

$$E = \frac{Z_1^2}{Z_2^2} \times \frac{n_2^2}{n_1^2}$$

⊛ Relationship btw Total energy / kinetic energy / potential energy

$TE = -KE$

$TE = \frac{PE}{2}$

$-KE = \frac{PE}{2}$

$PE > KE = TE$

$\downarrow \quad \downarrow \quad \downarrow$

$-ve \quad +ve \quad -ve$

Note: This all derivation only possible with the help of derivation of Rutherford

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

Postulate 4 : Electron can easy transit between higher energy level to lower energy level (Higher orbit to lower orbit)

- When e^- transit from lower orbital to upper orbital, they absorb photon and when they come back, they emit photon. According to this concept — Bohr present model of Hydrogen spectrum

Difference btw absorbtion spectrum and Emmission spectrum

Emission spectrum	Absorption spectrum
i. The spectrum is formed when e^- jumps from higher orbits to lower.	The spectrum is formed when e^- jumps from lower orbit to higher orbit
ii. It is formed due to emission of energy in quanta	It is formed due to absorption of energy in quanta
iii. It can be continous or discontinous	It is always discontinuous

Hydrogen spectrum

Hydrogen spectrum is initially type of spectrum In this transition different types of photons come back to lower orbital. and form spectrum.

* Energy of photon during different types of transition.

n_1 = name
$n_2 = n_1$ + no. of lines.

Q. Balmer 2nd line transition
↓
$n_1 = 2$

$n_2 = n_1$ + no. of lines
$= 2 + 2 \Rightarrow 4$

Que paschen 3rd line

$\downarrow$

$n_1 = 3$

$n_2 = n_1 + 3$

$= 3 + 3 = 6$

n_2 = balmer

n_3 = paschen

n_4 = bracket

n_5 = P fund

Que. Bracket 2nd line

$\downarrow$

$n_1 = 4$

$n_2 = 4 + 2$

$= 6$

$$\Delta E = E_2 - E_1$$

$$\Delta E = h\nu = -\frac{2\pi^2 k^2 z^2 e^4 m}{n_2^2 h^2} + \frac{2\pi^2 k^2 z^2 e^4 m}{n_1^2 h^2}$$

$$= \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]\left[\frac{2\pi^2 k^2 z^2 e^4 m}{h^2}\right.$$

$$\Delta E = 13.6\, z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\Delta E = h\nu = \frac{2\pi^2 k^2 z^2 e^4 m}{h^2}\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\frac{hc}{\lambda} = \frac{2\pi^2 k^2 z^2 e^4 m}{h^2}\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\frac{1}{\lambda} = \frac{2\pi^2 k^2 z^2 e^4 m}{h^3 c}\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

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

$$R = \frac{2\pi^2 k^2 e^4 m}{h^2 c}$$

$$= 10^7 \, m^{-1}$$

$$\boxed{\frac{1}{R} = 912\,\text{Å}}$$

Rydberg's constant

$$\boxed{\frac{1}{\lambda} = \bar{\nu} = RZ^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]}$$

wave number

wave length

$$r_n = 0.529 \times \frac{n^2}{Z}\ \text{Å}$$

$$V_n = 2.188 \times 10^6 \times \frac{Z}{n}\ m/sec$$

$$E = -13.6 \times \frac{Z^2}{n^2}\ eV/atm$$

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

7. Calculate the radius of 1st, 2nd, 3rd, 4th orbit of hydrogen atom. ?

$n_1 = 1$, $Z = 1$

$\Rightarrow r = 0.529 \times \frac{n^2}{Z}$

$= 0.529 \times \frac{1^2}{1}$

$= 0.529$

$n_2 = 2$, $Z = 1$

$\Rightarrow r = 0.529 \times \frac{2^2}{1} \Rightarrow 2.116\,A^{\circ}$

$n_3 = 3$, $Z = 1$

$\Rightarrow r = 0.529 \times \frac{3^2}{1} = 4.761\,A^{\circ}$.

$n_4 = 4$, $Z = 1$

$\Rightarrow r = 0.529 \times \frac{4^2}{1} = 8.464\,\mathring{A}$

excited State = +1

Que. Calculate the radius ratio of 3^{rd} and 5^{th} orbit of He^+

given $n_1 = 3$ $Z_1 = {}_2He^+ = 2$
$n_2 = 5$ $Z_2 = {}_2He^+ = 2$

$$\frac{r_1 = 0.529 \times \frac{3^2}{2}}{r_2 = \cancel{0.529} \times \frac{5^2}{\cancel{2}}} \rightleftharpoons \frac{3^2}{5^2} = \frac{r_1}{r_2} = \frac{9}{25}.$$

Que Calculate the radius ratio of 2^{nd} orbit of Hydrogen and 3^{rd} orbit of Li^{2+}

Given $n_1 = 2$, $Z_1 = H = 1$
$n_2 = 3$, $Z_2 = Li^{3+} = 3.$

$$\frac{r_H = \cancel{0.529} \times \frac{2^2}{1}}{r_{Li^{2+}} = \cancel{0.529} \times \frac{3^2}{3}} = \frac{4}{3}$$

Que. Calculate the radius ratio of 2nd excited state of Hydrogen and 1^{st} excited state of Li^{2+}

$n_1 = 2+1 = 3$, $Z_1 = H = 1$
$n_2 = 1+1 = 2$, $Z_2 = Li^{2+} = 3.$

$$r_H = \cancel{0.529} \times \frac{3^2}{1} = \frac{3^2 \times 3}{2^2} = \frac{27}{4}$$

$$r_{Li}^{2+} = 0.529 \times \frac{2^2}{3}$$

DPP-04

4. $n = 2$, $z = 3$

$n = 4$, $z = 3$

$$\text{radius} = \frac{0.529 \times \frac{n^2}{z}}{0.529 \times \frac{4^2}{z}} \Rightarrow \frac{\cancel{0.529} \times \frac{2^2}{3}}{\cancel{0.529} \times \frac{4^2}{\cancel{3}}} = \frac{4}{16} = 1:4$$

5. $n = 4$, $z = 2$

$n = 3$, $z = 4$

$$\frac{\cancel{0.529} \times \frac{4^2}{\cancel{2}}}{\cancel{0.529} \times \frac{3^2}{4}} = \frac{16}{\cancel{2}} \times \frac{\cancel{4}^2}{9} = \frac{32}{9}$$

6. $z = Li^{2+} - 3$
$\quad 3$

$$\frac{r_1}{r_2} = \frac{1}{9}$$

$$\frac{r_1}{r_2} = \frac{\cancel{0.529} \times \frac{n_1^2}{\cancel{z^2}}}{\cancel{0.529} \times \frac{n_2^2}{\cancel{z^2}}}$$

$$\sqrt{\frac{1}{9}} = \sqrt{\frac{n_1^2}{n_2^2}} \Rightarrow \frac{1}{3} = \frac{n_1}{n_2}$$

DPP = 5

1 $n = 3+1 = 4$, $z = 3$

$$\frac{0.529 \times 4^2}{3} = \frac{0.529 \times 16}{3} = 2.82\,\mathring{A}$$

2. $n = 2+1$, $z = 1$

$n = 1 + 1$, $z = 3$

$$\frac{\frac{0.529 \times 3^2}{1}}{\frac{0.529 \times 2^2}{3}} = \frac{0.529 \times 9}{\frac{0.529 \times 4}{3}} = \frac{4.761}{0.7053} = \frac{14.283}{2.116} = \frac{27}{4}$$

3. $TE = \frac{PE}{2}$

$-0.54 \times 2 = PE$

$-1.08\, ev$

4. $T = 1.5 \times 10^{-16} \times \frac{n^3}{z^2}$ $z = 3 = Li$ $n = 3$

$= 1.5 \times 10^{-16} \times \frac{3^3}{3^2}$

$= 1.5 \times 3 \times 10^{-16}\, s$

$= 4.5 \times 10^{-16}\, s$

5. $\Delta E = E_4 - E_1$ $z = 1$ $n = 4$

$E_4 = -13.6 \times \frac{z^2}{n^2}$

$= -\frac{13.6}{16} = -0.85$

$E_1 = -13.6 \times \frac{z^2}{n^2} = -13.6$

$\Delta E = E_4 - E_1$

$= -0.84 + 13.6$

$= 12.75\, ev$

6. $z = 3$

$n = 1$

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

$= -13.6 \times 9$

$= -122.4\, ev$

Que. Calculate the velocity of an e^- present in 3rd orbit of hydrogen atom also calculate the revolution per sec that this e^- around the nucleus?

Sol

$Z = {}_1H = 1$

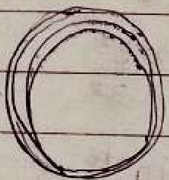
$n = 3$

$$V_n = 2.188 \times 10^6 \times \frac{Z}{n} \text{ m/sec}$$

$$= 2.188 \times 10^6 \times \frac{1}{3} \text{ m/sec}$$

$$= 0.729 \times 10^6$$

$$= 7.3 \times 10^5 \text{ m/sec}$$



$= n = 2\pi r$

↓

no. of turns/sec.

$$T = \frac{D}{V}$$

$$\frac{1}{T} = \frac{V}{D} = \frac{7.29 \times 10^5}{2\pi r}$$

↓

frequency

↓

no. of turn/sec

$$n = \frac{7.29 \times 105 \times 2}{2 \times 3.14 \times 0.529 \times n^2}$$

$$n = \frac{7.29 \times 10^5 \times 1}{2 \times 3.14 \times 0.529 \times 3^2 \times 10^{-10}} \text{ m/sec}$$

$$n = \frac{7.29 \times 10^5 \times 10^{10}}{2 \times 3.14 \times 0.529 \times 9}$$

$$n = 2.438 \times 10^{14} \text{ rev/sec}$$

$$\boxed{\text{no. of turns} = \frac{v}{2\pi r}}$$

$$\boxed{\text{Time period} = \frac{2\pi r}{v}}$$

Que How much time an e^- will take for complete revolution in second orbit of He^+.

Given, $n = 2$

$z = {}_2He^+ = 2$

$$v = 2.188 \times 10^6 \times \frac{z}{n}$$

$$r = 0.529 \times \frac{n^2}{z} \times 10^{-10} \text{ Å}$$

$T = \frac{D}{V} \longrightarrow \frac{2\pi r}{V}$

$$T = \frac{2 \times 3.14 \times 0.529 \times \frac{2^2}{2} \times 10^{-10}}{2.188 \times 10^6 \times \frac{2}{2}}$$

$$\frac{2 \times 3.14 \times 0.529 \times 2}{2.188} \times 10^{-16}$$

3.03×10^{-16} sec

Note: $\boxed{T = 1.5 \times 10^{-16} \times \frac{n^3}{z^2}}$

$\frac{1}{T}$ = no. of turns

Que If total energy of e^- is -1.51 eV ~~volt~~ in hydrogen Find out KE, PE, radius of orbit and velocity of e^-.

Sol. TE = −1.51 ev

KE = 1.51 ev

PE = −3.02 ev

TE = −KE

$TE = \frac{PE}{2}$

$TE = -13.2 \times \frac{z^2}{n^2}$ $\quad z = 1$

$n = ?$

$-1.51 = -13.6 \times \frac{1^2}{n^2}$

$n^2 = \frac{-13.6}{-1.51} = 9$

$\boxed{n = 3}$

$r = 0.529 \times \frac{n^2}{z}$ Å

$= 0.529 \times \frac{3^2}{1}$ Å

$= 0.529 \times 9$ Å

$r = 4.761$ Å //

$V = 2.188 \times \frac{z}{n} \times 10^6$ m/s

$= 2.188 \times \frac{1}{3} \times 10^6$ m/s

$= 0.729 \times 10^6$

$V = 7.29 \times 10^6$ m/sec //

Que Calculate the energy of Li^{2+} ion for 2nd excited state

Sol $Z = {}_3Li^{2+} = 3$

$n = 2 + 1 = 3$

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

$$= -13.6 \times \frac{\cancel{3^2}}{\cancel{3^2}}$$

$$= -13.6\,ev$$

Que Calculate the ratio of energies of He^+ 1st and 2nd excited state.

$Z_1 = {}_2He^+ = 2$

$n_1 = 1 + 1 = 2$

$Z_2 = {}_2He^+ = 2$

$n_2 = 2 + 1$

$= 3$

$$E_1 = -13.6 \times \frac{Z^2}{n^2}$$

$$= -13.6 \times \frac{\cancel{2^2}}{\cancel{2^2}}$$

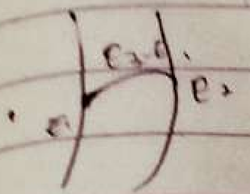
$$E_2 = -13.6 \times \frac{Z^2}{n^2}$$

$$= -13.6 \times \frac{2^2}{3^2}$$

$$\frac{E_1}{E_2} = \frac{\cancel{-13.6}}{\cancel{-13.6} \times \frac{2^2}{3^2}} = \frac{3^2}{2^2} = \frac{9}{4}$$

Que (8) The ionization energy for Hydrogen is 13.6 eV How much energy required to excite e^- form ground state to 4^{st} excited state?

$Z = 1 = H$



$$E = E_2 - E_1$$

$$= -13.6 \times \frac{Z^2}{n^2} - \left[-13.6 \times \frac{Z^2}{n^2} \right]$$

$n_1 = 1$
$n_2 = 2$

$$= -13.6 \times \frac{1^2}{2^2} + 13.6 \times \frac{1^2}{1^2}$$

$$= 13.6 \left[\frac{4}{1} - \frac{1}{4} \right]$$

$$= \frac{13.6 \times 3}{4}$$

$$= 10.2 \text{ eV}$$

(*). Hydrogen spectrum

Que In a Hydron spectrum e^- moves from 7^{th} to 1^{st} orbit. In this transition, find out the total line in this spectrum

Sol.

I. Lymen	$= 7-1$	$= 6$
II. Balmer	$= 7-2$	$= 5$
III. paschen	$= 7-3$	$= 4$
IV. Bracket	$= 7-4$	$= 3$
V. P fund	$= 7-5$	$= 2$
VI. Hamphrey	$= 7-6$	$= 1$

$$6+5+4+3+2+1 = 21$$

$$\boxed{\text{no. of lines in transition} = \frac{(n_2-n_1)(n_2-n+1)}{2}}$$

Que e^- move from 6^{th} to 2^{nd}. Calculate no. of lines.

$$\Rightarrow \frac{(6-2)[(6-2)+1]}{2} = \frac{4\times 5}{2} = 10$$

$$= 4\times(4+1)$$

Que In a Hydroden ~~atom~~ spectrum, e^- comes n to 1. The total no. of lines are 10. so calculate what is n.

$$10 = \frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2}$$

$$10 = \frac{(n_2 - 1)(n - 1 + 1)}{2}$$

$$10 \times 2 = (n-1)\, n$$

$$n^2 - n - 20 = 0$$

$$n^2 + 4n - 5n - 20 = 0$$

$$n(n-4) - 5(n-4)$$

$$(n-4)(n-5)$$

$$n = 4$$

$$\boxed{n = 5}$$

Que calculate the wavelength of 1st line of Balmer series in Hydrogen Spectrum

$R = 10^7$

$\frac{1}{R} = 912$

n_1 = Name = Balmer = 2

$n_2 = n_1 + \text{no. of line} = 2 + 1 = 3$

$\boxed{Z = 1}$

$$\frac{1}{\lambda} = R Z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\frac{1}{\lambda} = R \times 1^2 \left[\frac{1}{2^2} - \frac{1}{3^2}\right]$$

$$\frac{1}{\lambda} = R \left[\frac{9-4}{9 \times 4}\right]$$

$$\frac{1}{\lambda} = \frac{5}{36} \times R$$

$$\lambda = \frac{36}{5} \times R$$

$$= \frac{36 \times 912}{5} \text{ Å}$$

$$= 65\ \text{Å}$$

$\frac{1}{0} = \infty$

$\frac{1}{\infty} = 0$

Que. Calculate the frequency of last line of Lyman series in Hydrogen spectrum

Sol. frequency = $\nu = \frac{c}{\lambda}$

last line $\longrightarrow$ lymam = $n_1 = 1$

$n_2 = \infty$

$Z = 1 = H$

$$\frac{1}{\lambda} = R Z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\frac{1}{\lambda} = R 1^2 \left[\frac{1}{1^2} - \frac{1}{\infty^2}\right]$$

$$\frac{1}{\lambda} = R$$

$$\nu = \frac{c}{\lambda} = \frac{3\times10^3}{912\times10^{-10}} = \frac{3\times10^{18}}{912} = \frac{3000\times10^{15}}{912} \qquad (\text{Å} = 10^{-10})$$

$$= 3.29\times10^{15}\ Hz$$

Length of line $\propto E \propto \frac{1}{\lambda}$

Que The wave number of 1^{st} line Balmer of Hydrogen spectrum is $15200\ cm^{-1}$. The wave number of 1^{st} line of Balmer series of Li^{2+} will be?

Sol
$n_1 = 2$
$n_2 = 3$
$Z_1 = 1$ (H)
$Z_2 = 3$ (Li^{2+})

$$\frac{1}{\lambda_1} = \bar{\nu}_1 = \cancel{R} 1^2 \cancel{\left[\frac{1}{2^2} - \frac{1}{3^2}\right]}$$

$$\frac{1}{\lambda_2} = \bar{\nu}_2 = \cancel{R}\, 3^2 \cancel{\left(\frac{1}{2^2} - \frac{1}{3^2}\right)}$$

$$\frac{\bar{\nu}_1}{\bar{\nu}_2} = \frac{1}{9} = \frac{15200}{\nu_2} \Rightarrow \nu_2 = 15200 \times 9\ cm^{-1}$$
$$= 136800\ cm^{-1}$$

Que Calculate the ratio of maximum wavelength of lyman and balmer series.

Sol. $E = \frac{c}{\lambda}$

maxium wavelength = smallest line
lyman max wavelength = $2 \rightarrow 1$
Balmer max wavelength = $3 \rightarrow 2$

$$\frac{1}{\lambda_{lymen}} = R\,1^2 \left[\frac{1}{1^2} - \frac{1}{2^2}\right]$$

$$\frac{1}{\lambda_{balmer}} = R \times 1^2 \left[\frac{1}{2^2} - \frac{1}{3^2}\right]$$

$$\frac{\lambda_{balmer}}{\lambda_{lymen}} = \frac{\frac{4-1}{4}}{\frac{9-4}{36}}$$

$$\frac{\lambda_{balmer}}{\lambda_{lymen}} = \frac{3 \times \cancel{36}\,9}{\cancel{4} \times 5} = \frac{27}{5}$$

$$\frac{\lambda_{lymen}}{\lambda_{balmer}} = \frac{5}{27}$$

DPP-06

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

$n_2 = 5$
$n_1 = 1$
$\frac{(5-1) \times (5-\cancel{1}+\cancel{1})}{2} = \frac{20}{2} = 10$

2. $n_2 = 7$
$n_1 = 2$: (visible region)

$\cancel{\frac{(7-2)(7-2+1)}{2}}$ = $\frac{5 \times 6}{2} = \cancel{\frac{30}{2}}$

no. of line 5

3. $\frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2} = \frac{(4-1)(4-\cancel{1}+\cancel{1})}{2} = \frac{12}{2} = 6$

DPP-07

1. $\frac{1}{\lambda} = Rz^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$n_1 = 2$
$n_2 = \infty$
$z = 1$

$\frac{1}{\lambda} = R\,1^2 \left[\frac{1}{2^2} - \frac{1}{\infty^2}\right]$

$\frac{1}{\lambda} = \frac{1}{912} \quad 4 \times \frac{1}{R} = 4 \times 912\ \mathring{A}$

$\lambda = 912 \times 4 = 3648\ \mathring{A}$

2. $\frac{1}{\lambda} = Rz^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$n_1 = 1$
$n_2 = 1 + 2 = 3$

$\frac{1}{\lambda} = R\,1^2 \left[\frac{1}{1^2} - \frac{1}{3^2}\right]$

$\frac{1}{\lambda} = R \left[\frac{1}{1} - \frac{1}{9}\right]$

$\frac{1}{\lambda} = R \left(\frac{9-1}{9}\right)$

$\frac{1}{\lambda} = R\left(\frac{8}{9}\right)$

$\lambda = \frac{9}{8R}$

$\lambda = \frac{9}{8 \times 912} = 1026\ \mathring{A}$

$\nu = \frac{c}{\lambda} = \frac{3 \times 10^8}{1026 \times 10^{-10}}$

$= 2.92 \times 10^{15}$. Hz

3. $n_1 = 4$

$n_2 = 7$.

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

$$\frac{1}{\lambda} = R\left(\frac{1}{4^2} - \frac{1}{7^2}\right)$$

$$\frac{1}{\lambda} = R\left(\frac{1}{16} - \frac{1}{49}\right)$$

$$\frac{1}{\lambda} = R\left[\frac{49-16}{16 \times 49}\right]$$

$$\frac{1}{\lambda} = 912 \times 0.042 \quad \frac{784}{33R} = \frac{784 \times 912}{33} \text{ Å}$$

$\lambda = 21667$ Å

4. Lyman $= \infty - 1$ longest line $E \propto \nu$

Balmer $= \infty - 2$

$Z = 1$

$$\frac{\frac{1}{\lambda_1} = RZ^2\left[\frac{1}{1^2} - \frac{1}{\infty^2}\right]}{\frac{1}{\lambda_2} = RZ^2\left[\frac{1}{2^2} - \frac{1}{\infty^2}\right]}$$

$$\frac{\nu_1 = \frac{c}{\lambda_1}}{\nu_2 = \frac{c}{\lambda_2}}$$

$$\frac{\nu_1}{\nu_2} = \frac{\lambda_2}{\lambda_1}$$

$$= \frac{\lambda_2}{\lambda_1} = \frac{4}{1} = \frac{\nu_1}{\nu_2}$$

5. $\frac{1}{\lambda} = R\,1^2 \left[\frac{1}{2^2} - \frac{1}{5^2}\right]$

$\frac{1}{\lambda} = R \left[\frac{1}{4} - \frac{1}{25}\right]$

$\frac{1}{\lambda} = R \left[\frac{25-4}{100}\right]$

$\frac{1}{\lambda} = \frac{R21}{100}$

$\lambda = \frac{100}{R21}$

PYQ

Que In a hydrogen atom, if energy of an e^- in ground state is 13.6 ev. than that in the 2^{nd} excited state is

(a) 1.51 ev (b) 3.4 ev (c) 6.04 ev (d) 13.6 ev

$n = 1$, $= 13.6$ ev

$n = 2+1 = 3$

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

$= \frac{-13.6 \times 1^2}{3^2}$

$= -\frac{13.6}{9} = -1.51$ ev

$\boxed{E = +1.51 \text{ ev}}$

Que The wave number of the first emission line in the Balmer series of H- spectrum is :-

(a) $\frac{5}{36}R$ (b) $\frac{9}{400}R$ (c) $\frac{7}{6}R$ (d) $\frac{3}{4}R$

$$\bar{\nu} = R z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$n_1 = 2$

$n_2 = 2 + 1 = 3$

$$= R\, 1^2 \left[\frac{1}{2^2} - \frac{1}{3^2}\right]$$

$$= R\, \frac{9-4}{36}$$

$$= R\, \frac{5}{36}$$

Que What is the maximum wavelength line in the Lyman series of He^+ ion?

wavelength (λ) max

$\propto$ min

अंतिम line

$n_1 = 1$, $n_2 = 2$, $z = 2$.

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

$$\frac{1}{\lambda} = R\, 2^2 \left[\frac{1}{1^2} - \frac{1}{2^2}\right]$$

$$\frac{1}{\lambda} = R\, 4\, \frac{4-1}{4}$$

$$\frac{1}{\lambda} = R\, \cancel{4} \times \frac{3}{\cancel{4}}$$

$$\frac{1}{\lambda} = R3$$

$$\boxed{\lambda = \frac{1}{3R}}$$

Que The wave length of the light that must be absorbed to excite hydrogen electron from level n=1 to n=2 will be :

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

$$\frac{1}{\lambda} = R\,1^2\left[\frac{1}{1^2} - \frac{1}{2^2}\right]$$

$$\frac{1}{\lambda} = R\,\frac{3}{4}$$

$$\lambda = \frac{4}{3R}\,\mathring{A} = \frac{4}{3} \times 912\,\mathring{A} = 1325 \times 10^{10} = \boxed{1.325 \times 10^{-7}}$$

Que The energy of e^- in first Bohr orbit of H-atom is -13.6 ev. The energy value of e^- in the excited state of Li^{2+} is

$Z = Li^{2+} = 3$

~~n_1~~ excited

$n_2 = 1+1 = 2$

$$E = -13.6 \times \frac{3^2}{n^2}$$

$$= -13.6 \times \frac{3^2}{2^2}$$

$$= -13.6 \times \frac{9}{4} = -30.6\,ev$$

$$= 30.6\,ev$$

energy of e^- always +ve

Qu. What is the angular velocity (ω) of an e^- occupying second orbit of Li^{2+} ion?

$v = r \times \omega$

$\omega = \frac{v}{r}$

$$\omega = \frac{\frac{2\pi k z e^2}{nh}}{\frac{n^2h^2}{4\pi^2 k z e^2 m}}$$

$$\omega = \frac{8\pi^3 k^2 z^2 e^4 m}{n^3 h^3}$$

$z = 3 = Li^{2+}$

$n = 2.$

$$\omega = \frac{\cancel{8}\pi^3 k^2 \times 3^2 \times e^4 m}{\cancel{(2)^3} \times h^3}$$

$$\omega = \frac{\pi^3 k^2 9 e^4 m}{h^3} = 9\frac{\pi^3 k^2 e^4 m}{h^3}$$

Qu. Determine Bohr's radius of Li^{2+} ion for $n = 2$. given (Bohr's radius of H-atom $= a_0$) [Jee Mains P-I 2020]

$$r = 0.529 \times \frac{n^2}{z}$$

$z = 3$

$n = 2$

$$= a_0 \times \frac{2^2}{3}$$

$$= \frac{4a_0}{3}$$

Que The shortest wavelength of H atom in the Lyman series is λ_1. The longest wavelength in the Balmer series of He^+ is : (Jee main P-II 2020)

(a) $\frac{9\lambda_1}{5}$ (b) $\frac{36\lambda_1}{5}$ (c) $\frac{5\lambda_1}{9}$ (d) $\frac{27\lambda_1}{5}$

$\infty - 1$

$\lambda = \frac{1}{E}$

$$\frac{1}{\lambda_1} = RZ^2 \left[\frac{1}{1^2} - \frac{1}{\infty^2}\right]$$

$$\boxed{\frac{1}{\lambda_1} = R}$$

$$\frac{1}{\lambda_1} = R \times 2^2 \left[\frac{1}{2^2} - \frac{1}{3^2}\right]$$

$$\frac{1}{\lambda_1} = \times 4 \left(\frac{9-4}{9\times 4}\right)$$

$$\frac{1}{\lambda} = \frac{5}{9\lambda_1}$$

$$\boxed{\lambda = \frac{9\lambda_1}{5}}$$

Que The energy of one mole of photons of radiation of wavelength 300nm is (Jee Main P-I 2022)

$$E = \frac{nhc}{\lambda} = \frac{6.02\times10^{23} \times 2\times10^{-25}}{3\times10^{-7}}$$

$$= \frac{6.02 \times 2 \times 10^{23+7-25}}{3}$$

$$= 4\times10^{5} = 400\times10^{3}\ J/mol$$

$$= 400\ kJ/mol$$

Que The radius of hydrogen atom in the ground state is 0.53 Å. The radius of Li^{3+} ion in a similar state is. (AIPMT 1995)

$n = 1$

$z = 3$

$$r = 0.53 \times \frac{n^2}{z^2}$$

$$= \frac{0.53\times1^2}{3^2} = \frac{0.53}{9} = 0.17\ \text{Å}$$

Page No
Date

Que Bohr radius for the hydrogen atom ($n=1$) in approx $0.520\,\mathring{A}$. The radius for the first excited state $n=2$ is (in $\mathring{A}$) (AIPMT 1998)

$n = 1+1 = 2$

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

$= 0.53 \times \frac{2^2}{1} = 0.53 \times 4 = \boxed{2.12}$

Que ~~In hydrogen atom, energy of first~~ excited
The frequency of radiation emitted when the e⁻ falls from $n=4$ to $n=1$ in a hydrogen atom will be (given ionisation energy of $H = 2.18 \times 10^{-18}$ J atom⁻¹ and $h = 6.625 \times 10^{-34}$ Js) {AIMPT 2004}

(a) 1.54×10^{15} s^{-1}
(b) 1.03 —"—
(c) 3.08 —"—
(d) 2 —"—

$\frac{1}{\lambda} = RZ^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$\frac{1}{\lambda} = R\,1^2 \left(\frac{1}{4^2} - \frac{1}{4^2}\right)$

$\frac{1}{\lambda} = R\,\cancel{\frac{4-1}{8}}\,\frac{15}{16}$

$$\nu = \frac{c}{\lambda} = \frac{1}{\lambda} \times c$$

$$= \frac{15}{16} \times 1.1 \times 10^{7} \times 3 \times 10^{8}$$

$$= 3.08 \times 10^{+15}\ s^{-1}$$

Que The energy of second Bohr orbit of the hydrogen atom is $-328\ kJ\ mol^{-1}$, Hence the enegy of 4 th Bohr orbit would be [AIMPT - 2002]

~~(82) = 41~~

$$E = -1312 \times \frac{3^2}{n^2}\ kJ/mol$$

$$= -1312 \times \frac{1^2}{4^2}$$

$$= \frac{-1312}{16}$$

$$E = -82\ kJ/mol.$$

Que Which transition in the Hydrogen atomic spectrum will have the same wavelength as the Balmer transition (n = 4 to n = 2) of He^{+} spectrum)

(a) 4 , 3

(b) 3 2

(c) 4 2

(d) 2 1

(*) Drawback of Bohr's Atomic Model

- He could not explain the detail of the hydrogen and Helium atomic spetrum.

- He did not explain the splitting of spectral lines in presence of a magnetic field.

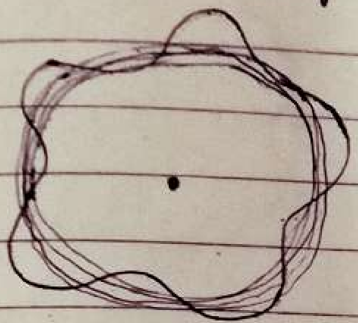
- The intensity of spectral lines was not explained by him

- He could not explain the splitting of spectral line in Magnetic field as well as splitting of spectral lines in electric field.

* De - Brogile

According to De - brogile any particle which is move with a linear momentum have its wavelength which is invesely proportional to the linear momentum.

Wave nature of matter



$$\lambda \propto \frac{1}{p} \longleftarrow \text{momentum } mv$$

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

$$\lambda = \frac{h}{mv}$$

$$KE = \frac{1}{2} mv^2 \times \frac{m}{m}$$

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

$$mv = p$$

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

$$p = \sqrt{2KEm}$$

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

$$\lambda = \frac{h}{\sqrt{2mKE}}$$

$KE = q \cdot V$ (voltage) (charge)

$$\lambda = \frac{h}{\sqrt{2mq.v}}$$

only for e^-

$$\lambda = \frac{h}{\sqrt{2\,m\,q.v}}$$

$h \rightarrow 6.6 \times 10^{-34}$

$m \rightarrow 9.1 \times 10^{-31}$ $\quad q \rightarrow 1.6 \times 10^{-19}$

$$= \sqrt{\frac{150}{V}}$$

$$\boxed{\lambda = \frac{12.25}{\sqrt{V}}\ \mathring{A}}$$ only of e^-

$V \rightarrow$ voltage

Einstein / Plank / De broglie

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

$E = mc^2 \rightarrow$ Einstein

$$\frac{h\cancel{c}}{\lambda} = mc^{\cancel{2}}$$

$$\frac{h}{\lambda} = m$$

$$\lambda = \frac{h}{mc}$$

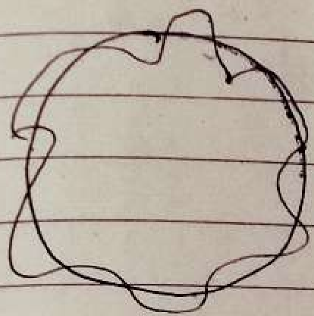
if ~~light~~ $\longrightarrow$ particle

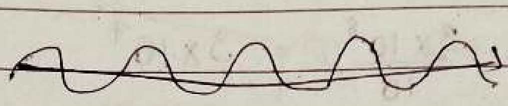
$c \xrightarrow[\text{changes}]{} V$

$$\boxed{\lambda = \frac{h}{mv}}$$

De - Broglie wave length

Bohr's & De - broglie Relation





$$\boxed{2\pi r = n\lambda}$$

$$2\pi r = n \times \frac{h}{mv}$$

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

Que If a mass of particle is 1g and move a velocity of 4.5×10^5 cm/sec. what is the wave length of the particle?

Given, $m = 1\,g$

$= 1 \times 10^{3}$ kg

$v = 4.5 \times 10^5$ cm/se

$= 4.5 \times 10^3$ m/s

$$\lambda = \frac{h}{mv}$$

$$\lambda = \frac{6.6 \times 10^{-34}}{1 \times 10^{-3} \times 4.5 \times 10^3}$$

$$= \frac{6.6}{4.5} \times 10^{-34}\ m$$

$$= 1.46 \times 10^{-34}\ m$$

Que If e^- move with a speed of $\frac{1}{10}$ th speed of light e^- what is the wavelength of these

Sol $\lambda = \frac{h}{mv}$

$v = \frac{1}{10} \times c$

$= \frac{3 \times 10^8}{10} = 3 \times 10^7$

$m = 9.1 \times 10^{-31}$ kg

$\lambda = \frac{6.6 \times 10^{-34}}{3 \times 10^7 \times 9 \times^{-31}}$

$= \frac{66}{2.7} \times 10^{-34-7+31}$

$\boxed{\lambda = 2.4 \times 10^{-11} m}$ 24×10^{-12}

24 pm

DPP = 06

2. $\lambda = \frac{h}{\sqrt{2mKE}}$

$\lambda_1 = \frac{h}{\sqrt{2mKE_1}}$

$\lambda_2 = \frac{h}{\sqrt{2mKE_2}}$

$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{KE_2}{KE_1}}$ $= 4 \times KE$ $= KE$

$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{4KE}{KE}}$

$\frac{\lambda_1}{\lambda_2} = 2.$

3. $\nu = \frac{c}{\lambda}$

$\lambda = \frac{c}{\lambda}$ —— ①

$\lambda = \frac{h}{mv}$

$v = \frac{h}{m\nu}$

$\boxed{v = \frac{h\nu}{mc}}$

4. $\lambda \propto \frac{1}{m_a}$

$e = 9.1 \times 10^{-31}$ kg.

$p = 1.67 \times 10^{-24}$ kg

$CO_2 = 44 \times 1.67 \times 10^{-24}$ kg [c]

$SO_2 = 64 \times 1.67 \times 10^{-24}$ kg

(*). Heisenberg's - Uncertainty principle

According to Heisenberg it is not possible to find the position of e^-.
So, the product of uncertainity of momentum, and position $\geq \frac{h}{4\pi}$

$$\underbrace{\Delta p}_{\text{uncertainity of momentum}} \cdot \underbrace{\Delta x}_{\text{position uncertainity}} \geq \frac{h}{4\pi}$$

Que The uncertainty of position of moving particle is 0, find out its momentum uncertanity.

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

$$\Delta p = \frac{h}{4\pi \times 0}$$

$$\boxed{\Delta p = \infty}$$

Que A ~~particle~~ ball of mass 150 g move with a velocity of 100 m/sec. What is the de-broglie wavelength of particle.

$\lambda = \frac{h}{mv}$

$m = 150 \times 10^{-3}$ kg

$v = 100$ m/sec

$\lambda = \frac{6.6 \times 10^{-34}}{150 \times 10^{-3} \times 100}$

$= \frac{6.6 \times 10^{-3}}{15}$

$= \frac{6.6 \times 10^{-34}}{15}$

$= 0.44 \times 10^{-34}$

$= 4.4 \times 10^{-35}$ approx

Que If a particle of 150 g have a position uncertainty of 1 Å. What is the velocity uncertainty of particle

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

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

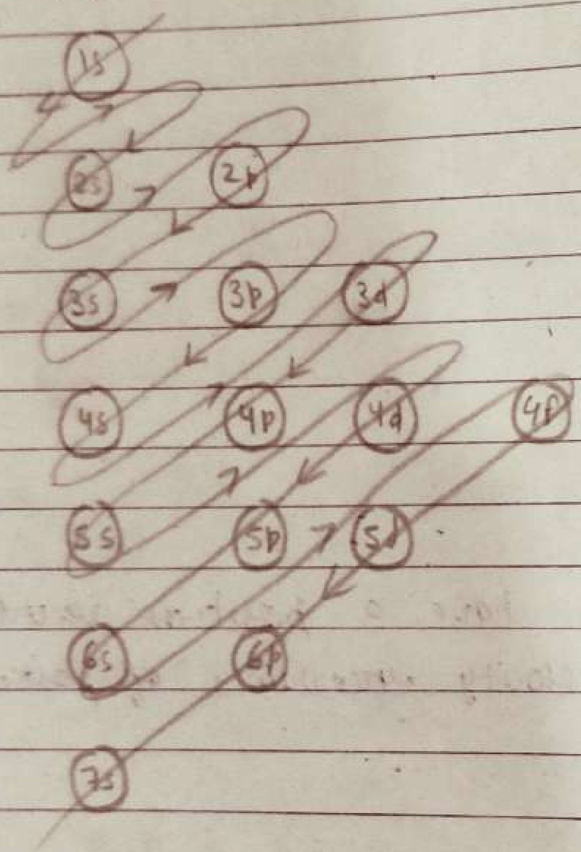
$= \frac{6.6 \times 10^{-34}}{4 \times 3.14 \times 150 \times 10^{-3} \times 1 \times 10^{-10}}$ m/s

$= 3.5 \times 10^{-24}$ m/s

* Electron filling Rules

→ Aufbau's Rule
→ Hund's Rule
→ Pauli's Rule

* Aufbau's Rule



$1s^1 < 2s^2 < 2p^6 < 3s^2 < 3p^6 < 4$
$3d^{10} < 4p^6 < 5s^2 < 4d^{10} < 5p < 6$
$4f^{14} < 5d^{10} < 6p^6 < 7s^2$

s^2
p^6
d^{10}
f^{14}

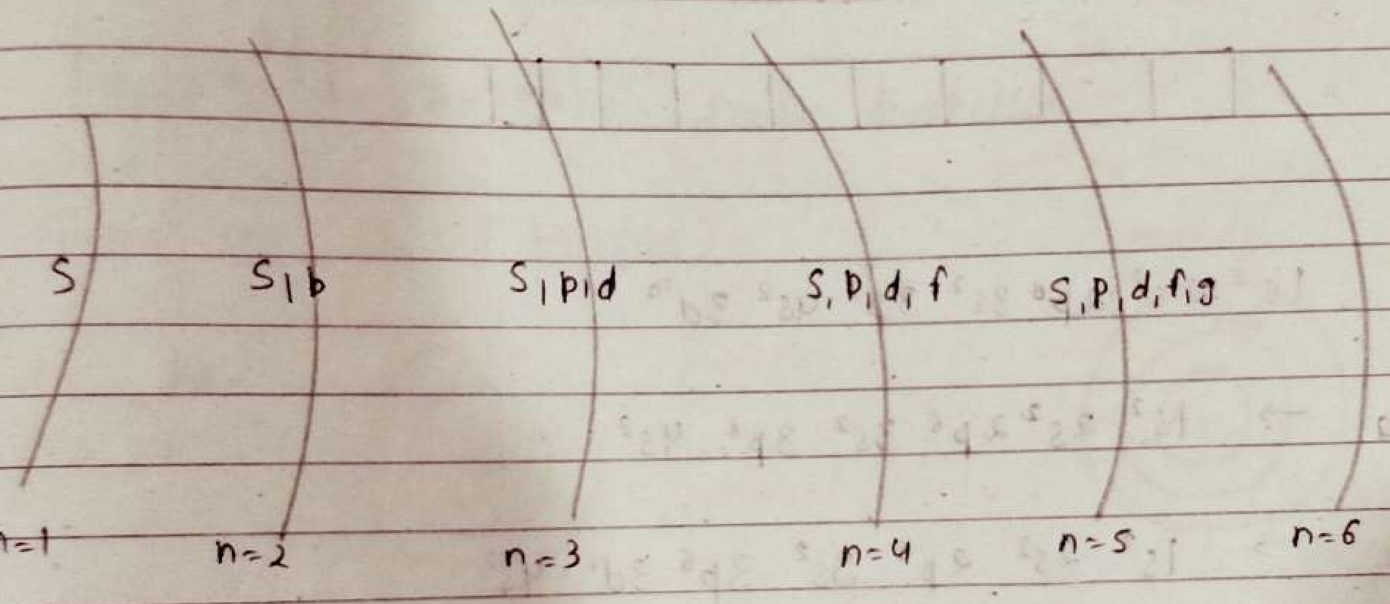
$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}$

$_{10}Ne = 1s^2\ 2s^2\ 2p^6$: 10

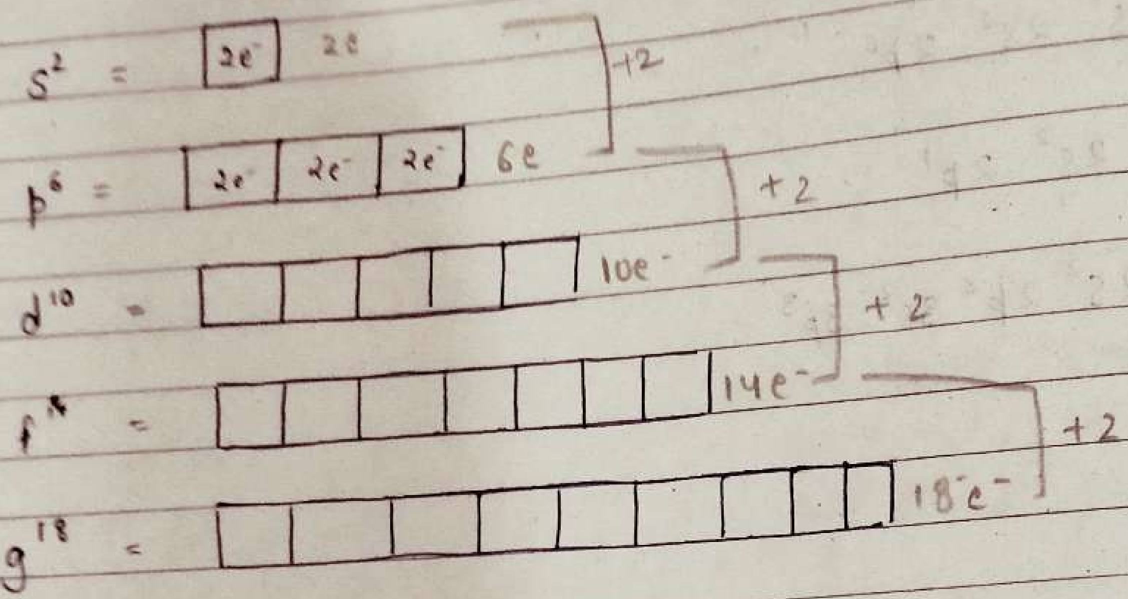
noble

$_{5}B = 1s^2\ 2s^2\ 2p^1$

$_{15}P = 1^{s}\ 2s^2\ 2p^6\ 3s^2\ 3p^3$



- 1p, 2d, 3f, 4g, 2d, 2f, 1d not valid. X



$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}$

At. 1 to 30
e⁻ config

$_{20}Ca \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

$_{21}Sc \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ \underline{3d^1\ 4s^2}$

$_{22}Ti \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2\ 4s^2$

$_{23}V \longrightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ 4s^2$

$\left.\begin{matrix} d^0 \\ d^5 \\ d^{10} \end{matrix}\right\}$ Stable configuration

$_{24}Cr$ - ~~$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4\ 4s^2$~~ ×

$1s^2\ 2s^2\ 2p^6\ 2s^2\ 3p^6\ \underline{3d^5\ 4s^1}$

$_{25}Mn$ - $1s^2\ 2s^2\ 2p^6\ 2s^2\ 3p^6\ \underline{3d^5\ 4s^2}$

$_{29}Cu$ - $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ \underline{3d^{10}\ 4s^1}$

⇒ due to stability of half-filled and full-filled subshell
d subshell

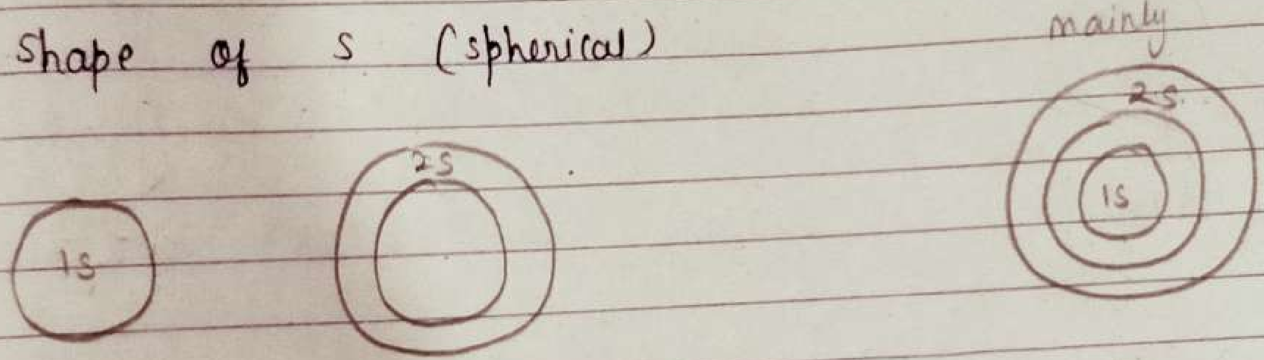
* Shapes of orbitals

s – $\boxed{}$ spherical

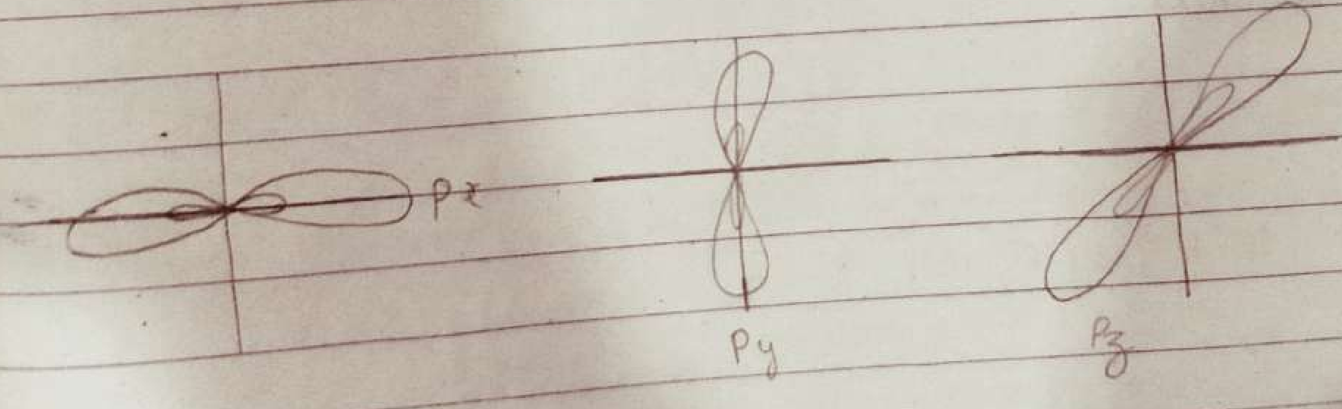
p – $\boxed{p_x}\boxed{p_y}\boxed{p_z}$ – dumbelled

d – $\boxed{d_{xy}}\boxed{d_{yz}}\boxed{d_{zx}}\boxed{d_{x^2y^2}}\boxed{d_{z^2}}$ – double dumbelled

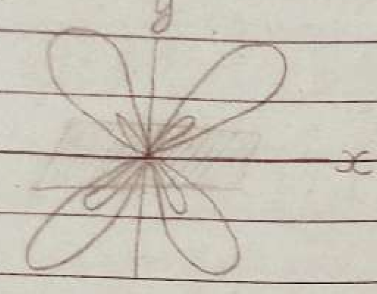
⇒ Shape of s (spherical)



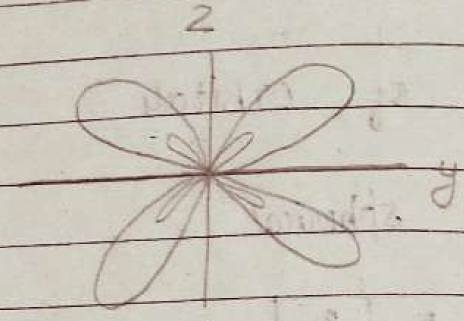
⇒ shape of p (dumbelled)



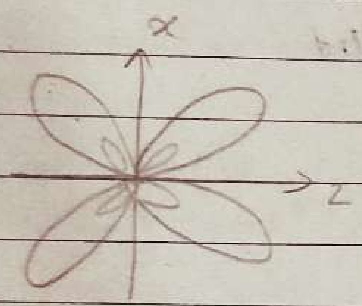
⇒ Shape of d orbitals (Double dumblect)



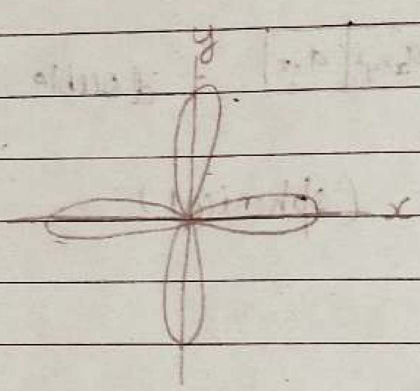
d_{xy}



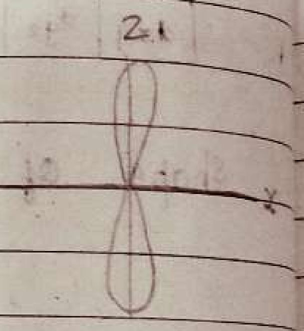
d_{yz}



d_{xz}



$d_{x^2y^2}$



d_{z^2}

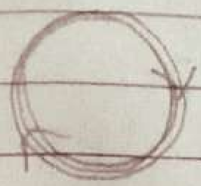
* Hund's Rule

Sub-shell

d^5	$2e^-$	$2e^-$	$1e^-$			X

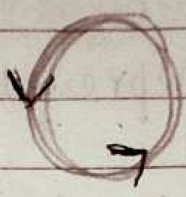
$1e^-$	$1e^-$	$1e^-$	$1e^-$	$1e^-$

* <u>Pauli's Rule</u>



Clockwise

↑



Anticlockwise

↓

1^{st} e^- - C.W

2^{nd} e^- - A.C.W

↑↓	↑↓	

Rule applied

I. | ↑↑ | ↑ | | Hund X Pauli X

II. | ↑↓ | ↑ | | Hund X Pauli ✓

III. | ↑↓ | ↑↑ | ↓↓ | | | Hund X pauli X

IV. | ↑ | ↓ | ↑ | ↓ | ↑ | Hund ✓ Pauli X

V. | ↑↓ | ↑ | ↑↓ | Hund X Pauli ✓

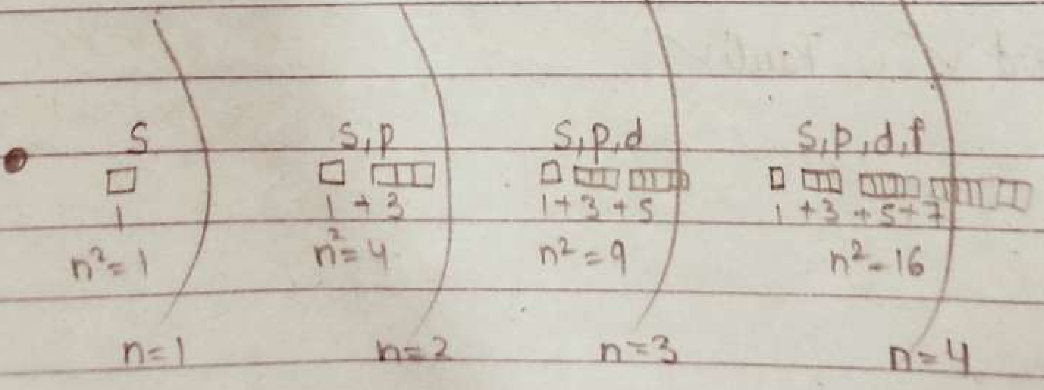
VI. | ↑↓ | ↑↓ | ↑ | Hund ✓ Pauli ✓

Quantum Numbers

Quantum Number represented address of e^-

I. Principle Quantum Number (Bohr's)

- denoted by 'n'
- It represents no. of shells/orbits
- It represents radius of orbit $= 0.529 \times \frac{n^2}{Z}$ Å
- It represents velocity of $e^- = 2.188 \times 10^6 \times \frac{Z}{n}$ m/s
- It represents energy of orbit $= -13.6 \times \frac{Z^2}{n^2}$ ev/atom
- It represents angular momentum $mvr = \frac{nh}{2\pi}$
- no. of orbitals $= n^2$
- no. of $e^- = 2n^2$



II Azimuthal Quantum Number / Angular Q. No / Subsidiary Q. No.

- denoted by 'l'
- It represents shape of sub-shell
- value $l_{max} < n$ $\boxed{\text{no. of } l = n}$

$n = 1$
$l = 0$

$l_{max} = n - 1$

$n = 2$
$l = 0, 1$

$n = 3$
$l = 0, 1, 2$

$n = 5$
$l = 0, 1, 2, 3, 4$

- Orbital angular momentum $= \sqrt{l(l+1)}\,\frac{h}{2\pi}$ $\frac{h}{2\pi} = \hbar$

no. of $e^- = 2(2l+1)$ $2(2l+1)$

in any subshell s, p, d, f, g.

sub-shell	l code
s	0
p	1
d	2
f	3
g.	4

$2(2l+1)$

$2 \times (2 \times 2 + 1)$

$10e^-$

Hypothetic $l = 7$ $2(2 \times 7 + 1)$

$30e^-$

* n + l rule

$\boxed{n+l \text{ max, energy max}}$

$4s = 4 + 0 = 4$

$3d = 3 + 2 = 5$

$4 < 5$

$\boxed{4s < 3d}$

Que Arrange the configration in the increasing order of their energy level

a. 4f b. 5d c. 6p d. 7s

$4+3=7$ $5+2=7$ $6+1=7$ $7+0=7$

$\boxed{4f < 5d < 6p < 7s}$

n + l = same
no. of orbit

(due to stability we use $+\frac{1}{2}$
[Spin . Q. No] $-\frac{1}{2}$

Que Arrange in the increasing order of their energy?

a. $2p$ b. $4s$ c. $3d$ d. $3s$

$2+1=3$ $4+0=4$ $3+2=5$ $3+0=3$

$$\boxed{2p < 3s < 4s < 3d}$$

$_9F \rightarrow 1s^2\ 2s^2\ 2p^5$

$2p^5$

$n=2$

$l=1$

Que $n+l=7$ may no. of e^- how much?

$$\boxed{n > l}$$

$7s^2$	7	+	0	=	7
$6p^6$	6	+	1	=	7
$5d^{10}$	5	+	2	=	7
$4f^{14}$	4	+	3	=	7

III Magnetic Quantum Number

- It is denoted by 'm'
- It represents orientation.

subshell	l	m
s	0	$\boxed{0}$
p	1	$\boxed{P_x}\boxed{P_y}\boxed{P_z}$ $-1 \quad 0 \quad +1$
d	2	$\boxed{-2}\boxed{-1}\boxed{0}\boxed{+1}\boxed{+2}$ $d_{xy} \quad d_{yz} \quad d_{zx} \quad d_{x^2y^2} \quad d_{z^2}$

$$m = l \begin{cases} \to -l \\ \to +l \end{cases}$$

$s = 1$
$p = 3$
$d = 5$
$f = 7$

$3d^3$

$n = 3$

$d = 2$

$m = 0$ $\quad \boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{}\boxed{}$

0

$_{11}Na = 1s^2\ 2s^2\ 2p^6\ (3s^1)$

$\downarrow$

$3s^1$

$n = 3$

$l = 0$

$m = 0$

$_5B = 1s^2\ 2s^2\ (2p^1)$

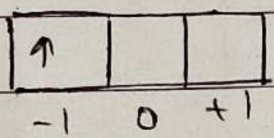
$\downarrow$

$2p^1$

$n = 2$

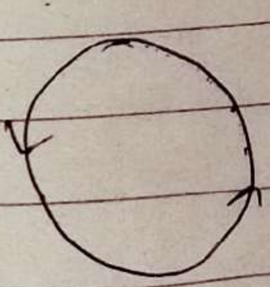
$l = 1$

$m = -1$

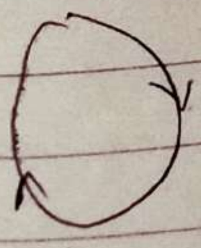


IV. Spin Quantum Number

- It is denoted by 's'
- It reprensents spin of e



ACW $\downarrow$ $-\frac{1}{2}$



CW $\uparrow$ $+\frac{1}{2}$

spin angular momentum of an e^- = $\sqrt{s(s+1)}\,\hbar$

Que $_{17}Cl$ last e^- all 4 Quantum No.

$_{17}Cl$ = $1s^2\,2s^2\,2p^6\,3s^2\,3p^5$

↓

$3p^5$

$n = 3$

$l = 1$

$m = 0$

$s = -\frac{1}{2}$

$-\frac{1}{2}$

↑↓	↑↓	↑
-1	0	+1

Que $_{17}Cl$ $m = 0$ how much e^- have

$1s^2\;2s^2\;2p^6\;3s^2\;3p^5$

↓ ↓ ↓ ↓ ↓

$m=0$ $m=0$ $m=0$ $m=0$ $m=0$

$2 + 2 + 2 + 2 + 2$

$= 10e^-$

Que $_{17}Cl$ = $s = +\frac{1}{2}$ how many e^-

$1s^2 \quad 2s^2 \quad 2p^6 \quad 3s^2 \quad 3p^5$

$\boxed{\uparrow\downarrow} \quad \boxed{\uparrow\downarrow} \quad \boxed{\uparrow\downarrow|\uparrow\downarrow|\uparrow\downarrow} \quad \boxed{\uparrow\downarrow} \quad \boxed{\uparrow\downarrow|\uparrow\downarrow|\uparrow}$

$1 + 1 + 3 + 1 + 3$

$= 9e^-$

Que which Q. No set is wrong

	n	l	m	s
a.	2	1	0	$+\frac{1}{2}$
b.	3	1	0	$+\frac{1}{2}$
c.	4	4	3	$+\frac{1}{2}$
d.	4	3	4	$+\frac{1}{2}$

(*). Number of Nodes

I. No. of Angular node = l

II. No. of radial node = $n - l - 1$

III. Total number of node = $n - \cancel{l} - 1 + \cancel{l}$
$= n - 1$

Que In 3s sub-shell ($n=3$, $l=0$)

a. Total no. of radial node = $n - l - 1 = 3-0-1$
$= 2$

b. Total no. of Angular node = $l = 0$

c. Total no. of Total node = $n - 1 = 3-1 = 2$

Que 4p orbitals ($n=4$, $l=1$)

a. no. of total nodes = $n - 1 = 4 - 1 = 3$

b. No. of radial nodes = $n - l - 1 = 4 - 1 - 1$
$= 2$

c. No. of angular nodes = $l = 1$

(*). Schrodinger wave equation ψ = si

schrodinger wave function

mass of e^-

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

second derivative of x

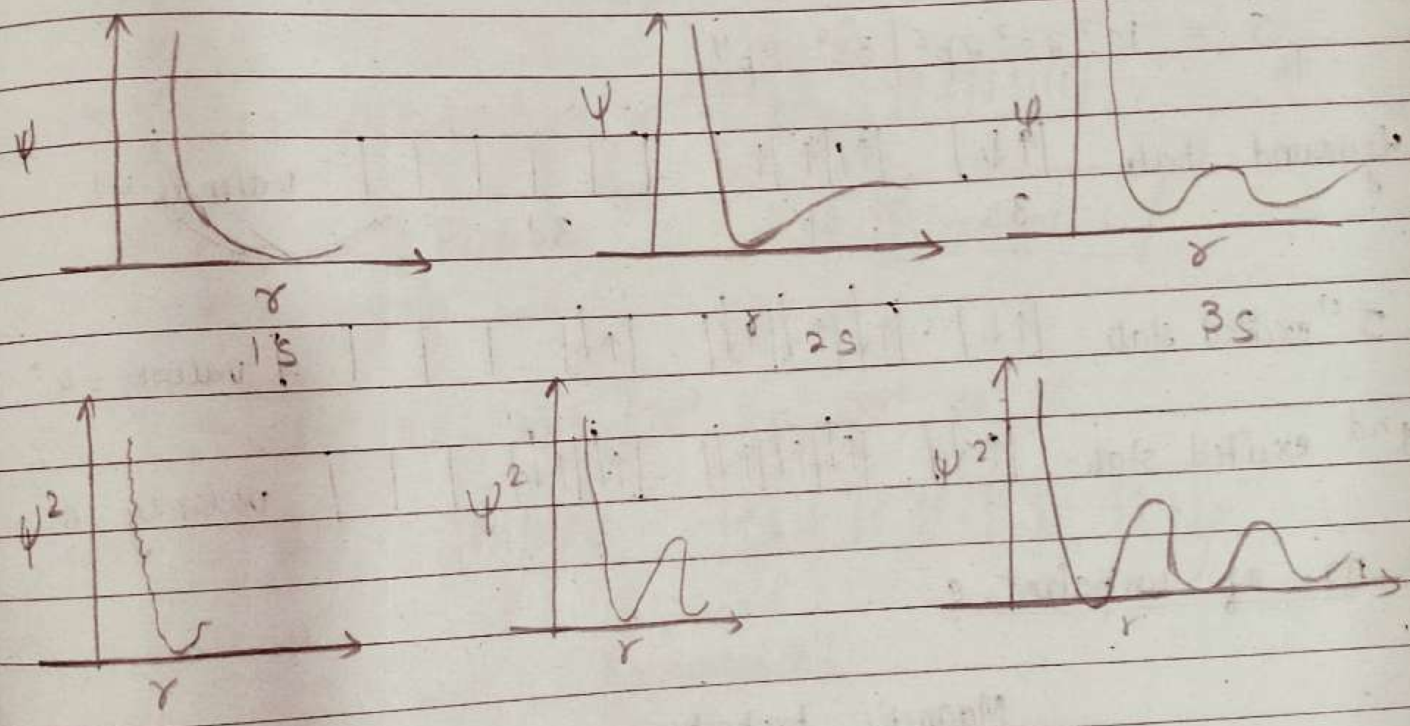
plank's constant

energy

voltage

ψ = orbital wave function

ψ^2 = variable of probibitity density



Ground state

Valency :

Oxygen - $^{16}_{8}O \longrightarrow 1s^2 \, [2s^2 \, 2p^4$

outermost orbits

Ground state [↑↓] [↑↓|↑↓|↑↓] valency = 2

2s 2p

$_{16}S = 1s^2 2s^2 2p^6 \, [3s^2 \, 3p^4$

Ground state [↑↓] [↑↓|↑|↑] . [| | | |] valency = 1

3s 3p 3d

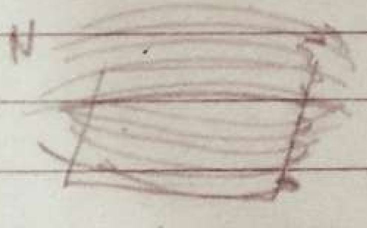
Ist excited state [↑↓] [↑↓|↑↓|↑↓] [↑↓| | | |] valency = 4

IInd excited state [↑↓] [↑↓|↑↓|↑↓] [↑↓|↑↓| | |] valency = 6

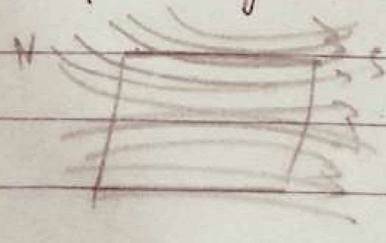
no. of unpaired e^-

Magnetic property

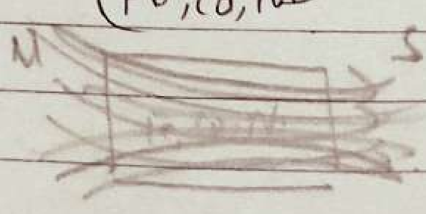
Dimagnetic



paramagnetic



ferromagnetic (Fe, Co, Ni)



Dimagnetic ⟶ ~~un~~paired no. of e^-

paramagnetic ⟶ unpair e^- avilable

$\mu = \sqrt{n(n+2}$ BM
(Bohr magneton)

Na^+ - $\boxed{\uparrow\downarrow}$ $\boxed{\uparrow\downarrow|\uparrow\downarrow|\uparrow\downarrow}$ $\boxed{\uparrow}$ ⟶
2s 2p 3s

$_{11}Na = 1s^2\ 2s^2\ 2p^6\ 3s^1$ $\boxed{\uparrow\downarrow}$ $\boxed{\uparrow\downarrow|\uparrow\downarrow|\uparrow\downarrow}$

$\boxed{\text{Dimagnetic}}$

+ve - e^- Remove
-ve - gain

$_{26}Fe \rightarrow 1s^2\ 2s^2\ 2p^6\ [3s^2\ 3p^6\ 3d^6\ 4s^2$

$_{26}Fe^{+2}$ $\boxed{\uparrow\downarrow}$ $\boxed{\uparrow\downarrow|\uparrow\downarrow|\uparrow\downarrow}$ $\boxed{\uparrow\downarrow|\uparrow|\uparrow|\uparrow|\uparrow}$ $\boxed{\uparrow\downarrow}$

paramagnetic
n = 4

$\mu = \sqrt{n(n+2} = \sqrt{4(4+2} = \sqrt{24}$ BM

$l > m$

$n \neq l$

full. fill

Cr_{24} - $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$

$\boxed{\uparrow \mid \uparrow \mid \uparrow \mid \uparrow \mid \uparrow}$ $\boxed{\uparrow}$

$n = 6$

paramagnetic

Qu Which of the following sets of quantum numbe is not allowed [JEE main P-II 2022]

a. $n=3$, $l=2$, $m=0$, $s=+\frac{1}{2}$

b. $n=3$, $l=2$, $m=-2$, $s=+\frac{1}{2}$

c. $n=3$, $l=3$, $m=-3$, $s=-\frac{1}{2}$

d. $n=3$, $l=0$, $m=0$, $s=-\frac{1}{2}$

Qu given below are the quantum number for 4 e^- [JEE main P-II 2022]

n+l Rule

a. $n=3$, $l=2$, $m=1$, $m_s=+\frac{1}{2}$ 3d = 3+2 = 5

b. $n=4$, $l=1$, $m=0$, $m_s=+\frac{1}{2}$ 4p = 4+1 = 5

c. $n=4$, $l=2$, $m=-2$, $m_s=-\frac{1}{2}$ 4d = 4+2 = 6

1. $n=3$, $l=1$, $m=-1$, $m_s=+\frac{1}{2}$ 3p = 3+1 = 4

The correct order of increasing energy is :

a. $D < B < A < C$ b. $D < A < B < C$

c. $B < D < A < C$ d. $B < D < C < A$

Que Consider the following pair of e^- [JEE main P-I 202]

(a) (i) $n = 3$, $l = 1$, $m = 1$, $m_s = +\frac{1}{2}$

(ii) $n = 3$, $l = 2$, $m = 1$, $m_s = +\frac{1}{2}$

(b) (i) $n = 3$, $l = 2$, $m = -2$, $m_s = -\frac{1}{2}$

(ii) $n = 3$, $l = 2$, $m = -1$, $m_s = -\frac{1}{2}$

(c) (i) $n = 4$, $l = 2$, $m = 2$, $m_s = +\frac{1}{2}$

(ii) $n = 3$, $l = 2$, $m = 2$, $m_s = +\frac{1}{2}$

The pairs of e^- present in degenerate orbital is/are :-

a. Only a b. Only (b) c. Only (c) d. (b) and (c)

Que In the sixth period, the orbitals that are filled are : [JEE Main P-II 2020]

a. 6s, 5f, 6d, 6p b. 6s, 5d, 5f, 6p

c. 6s, 6p, 6d, 6f d. 6s, 4f, 5d, 6p

Que The no. of subshells associated with $n = 4$ and $m = -$ quantum no. is (JEE main - P II 2020)

(a) 16 (b) 8 (c) 4 (d) 2

$n = 4$ s p d f

m no. given than 4.

Que The quantum number of 4 e^- are given below. (JEE Main 2019)

I. $n = 4$, $l = 2$, $m = -2$, $m_s = -\frac{1}{2}$ 6

II. $n = 3$, $l = 2$, $m = 1$, $m_s = +\frac{1}{2}$ 5

III. $n = 4$, $l = 1$, $m = 0$, $m_s = +\frac{1}{2}$ 5

IV. $n = 3$, $l = 1$, $m = 1$, $m_s = -\frac{1}{2}$ 4

The correct order of their increasing energies will be -

a. IV < III < II < I

b. IV < II < III < I ✓

c. I < II < III < IV

d. I < III < II < IV

Que The electronic configuration of Cu (at. no. = 29) is (AIPMT 1991)

b. $1s^2, 2s^2, 2p^6, 3s^2, 3d^{10}\ 4s^1$

Que The orbitals are called degenerate when (AIPMT 1996)

d. they have the same energy.

Que Which of the following is not permissible arrangement of e^- in an atom? (AIPMT 2009)

a. $n = 4$, $l = 0$, $m = 0$, $s = -\frac{1}{2}$

b. $n = 5$, $l = 3$, $m = 0$, $s = +\frac{1}{2}$

✓ $n = 3$, $l = 2$, $m = -3$, $s = -\frac{1}{2}$

d. $n = 3$, $l = 2$, $m = -2$, $s = -\frac{1}{2}$

Que Consider the following sets of quantum number.

	n	l	m	s
a.	3	0	0	$+\frac{1}{2}$
b.	2	2	1	$+\frac{1}{2}$
c.	4	3	-2	$-\frac{1}{2}$
d.	1	0	-1	$-\frac{1}{2}$
e.	3	2	3	$+\frac{1}{2}$

Which of the following sets of quantum number is not possible? (AIPMT 2007)

a. b, c and d

b. a, b, c and d

✓ b, d and e

d. a and c

Que The correct set of 4 quantum numbers for the valence electron of rubidium atom (at. no.= 37) is (AIIMPT 2012)

a. 5, 1, 1, $+\frac{1}{2}$

b. 6, 0, 0, $+\frac{1}{2}$

✓c. 5, 0, 0, $+\frac{1}{2}$

d. 5, 1, 0, $+\frac{1}{2}$

Que Maximum no. of e^- in a subshell with $l = 3$ and $n = 4$ {AIPMT 2012}

✓a. 14 b. 16 c. 10 d. 12

Que What is the maximum no. of e^- that can be associated with the following set of quantum no's? (NEET 2013)

$n = 3$, $l = 1$, and $m = -1$

a. 10 b. 6 c. 4 ✓d. 2

Que Two e^- occupying the same orbitals are distinguised by (NEET (phase I) 2016)

a. Magnetic Q. No.
b. Azimuthal Q. No
✓c. Spin Q. No
d. Principle Q. No

Que Orbital having 3 angular nods and 3 total nods is (Neet Odisha 2019)

a. 5p b. 3d ✓c. 4f d. 6d

angular node = $l = 3$

Totale node = $n - 1 = 3 \Rightarrow n = 3+1$

$n = 4$

4+2=6 5+1=6 5+3=8 6+1=7

Que 4d, 5p, 5f and 6p-orbitals are arranged in the order of decreasing energy. The correct option is (Neet 2019)

a. $6p > 5f > 5p > 4d$
b. $5p > 5f > 4d > 5p$
c. $5f > 6p > 4d > 5p$
✓d. $5f > 6p > 5p > 4d$

Que The no. of angular nodes and radial node in 3s orbital are [NEET 2020]

a. 0 and 2
b. 1 and 0
c. 3 and 0
d. 0 and 1

3s

$n = 3, l = 0$

angular node = $l = 0$

radial node = $n - l - 1$

$= 3 - 0 - 1$

$= 2.$