22-July-23. **Ch#2** Saturday

Atomic Structure

"The study of structure of atoms & sub-atomic particle is Atomic structure."

Structure Of Atom

The modern has proofed that atoms are made up 100 particles of which electrons and neutron are whole existing & other imp particles.

Dalton's Theory

It has five main points:

1- Matter is made up of small atoms & sub-atomic particle.

2- All atom ~~have the same~~ of same element are identical and have same mass.

3- Atoms of different elements vay in size, mass & chemical behavior.

4- Compound is form by combination of two or more different atoms.

5- A chemical reaction is the rearrangment of atoms

Made up of

→ Atoms are made up of sub-atomic particle, electron, neutron & proton these are elementary or fundamental particles.

→ Other particles made be neutrino, antineutrino, positron, pions and muons binded together with eachother.

Cathode Rays

Discharge Tube Experiment

History Background

→ J.J Thomson first identified the electrons in Cathode ray tube (electric discharge tube) in 1887. Many other scientists like Faraday & Crookes studied the negative effects of passing electric current through a gas. As an result sub-atomic particle with negative charge was discovered.

→ J.J. Thomson discovered electrons in 1887.

→ Name 'electron' was given by stoney in 1886

Construction Of Discharge Tube

- A gas discharged tube is fitted with two metallic electrodes, (cathode, anode).
- The tube is filled with a gas, air or vapour of a substance at any desired pressure.
- The electrodes are connected to the source of high voltage battery.
- The tube is attached to the pump.

Mechanism

Steps

- Vaccum formation
- Cathode heating
- Electrons acceleration
- Collisions
- Cathode rays are formed

Explanation

At first electric current was passed through the gas in discharge tube at ordinary pressure.
The gas was not effected at a potential of 5000 v.
Now gas was pumped out not all by vacuum pump causing a decrease in atm:
The pressure was 0.01 torr & 5000-10000 v.
It was observed that at these particul ar

requirement, the gas becomes conductor. & current starts to flow causing emittion of light (neon sign).
Pressure was further lowered to 0.01 torr emission of light become more visible due to absence of gas.
These light were emitting by cathode & travel towards anode.
That is why known as Cathode rays.

Applications

Helps in:

- Analytical instruments
- help to visualize chemical reaction through interaction with material.

24/07/23 Monday

Properties Of Cathode

Deflection

Cathode rays are negatively charged. There show deflection by both magnetic field & electric field.

Cathode are attracted by north pole.

Cathode are attracted by anode.

Shadow Cast

Electron beam move in a straight line. This can be proved by putting a cross in the path across ejected beam of e^- when they can not pass through the cross, & left one shrilce the wall producing glow & shadow. (90°).

Momentum

We now that electrons have less mass but have velocity. Therefore, they create momentum. If we place small paddle in its path, it will cause it move.

Production of x-rays

Cathode rays carry energy. Therefore, when then shike to surface, surface absorbs energy & emits light x-rays due to emergence of photons.

Glow of foils

When platinum & alumim foil are placed, cathode rays strike to their surface, they give electron, which the surface absorbs & emits photons in the form of glow.

Ionizing

electron are too small that they can easily ~~penetrate~~ ionize gases.

Chemical composition change

Basically, electron have high speed but less than light speed, when they enter in a molecules, compound, they get absorbed & change their shape symmetrically.

Penetration

Electrons have small size & can absorbed easily, therefore they penetrate easily.

25/07/23 Tuesday

Atomic Structure

Measurement of Charge

Discovery

R.A Maillikan Succeeded in measuring the charge of electron with great precision in 1909.

Construction

Millikan constructed is inthis manner.

A box: A box containing two chambers.

Chamber A: Chamber A has a atomizer containing the oil droplets inside it. At base of chamber A has a pin hole. The chamber A also has electrode of positive terminal.

Chamber B: Chamber B has Telescope at its one hole of wall. At second wall, a pinhole is present. The electrode of negative terminal is present.

Arc lamp: Arc lamp is present between two electrodes to see movement of droplets.

Air: The first chamber A has air also maintained at desired pressure.

Mechanism

→ When atomizer is pumped, the air droplets are scattered.

→ Through the wall, air is present in chamber A it will more through pin hole. Another pin hole, X-rays are entered, which ionizes the air & make it an electron.

→ Presence of arc lamp helps to see the movement through telescope.

Mathematically

When air was present at chamber A. The weight & gravitional force was pulling down. This moremen of air has velocity So, we can write as:

$$F_w = mg \quad (i)$$

$$V_1 \propto mg$$

$$V_1 = kmg \quad (iii)$$

As the air more down through pin hole, the positive electrode starts to pull it up & weight is pulling down. Hence, equilibrium condition is present.

Electric field was not present in chambe A becoz. fieldis from + ⟶ -.

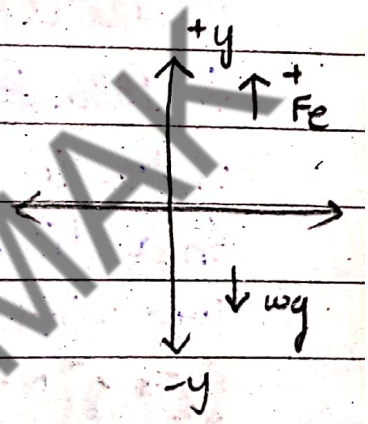
$$F = qE$$

$$F_e = eE \quad \text{(ii)}$$

$\therefore q = e$ (electron)

$V_2 \propto +F_e - F_{ew}$.

$V_2 = K(eE - mg)$. (iv)



combine eq, (iii) & (iv).

$$\frac{V_1}{V_2} = \frac{Kmg}{K(eE - mg)}$$

$$\boxed{\frac{V_1}{V_2} = \frac{mg}{eE - mg}.}$$

If V_1, V_2, g & E are known, the mass of electron can be determined by varying the electric field. Where.

$e = 1.6022 \times 10^{-19}$ coulombs.

$\frac{e}{m} = 1.7588 \times 10^{11} \frac{\text{Coulomb}}{\text{kg}}$.

26/07/23 Wednesday

Positive Rays

Introduction

In 1886, Goldstein a German Physicist discovered proton in the cathode ray Tube.
In a discharge tube, atoms, or molecules lose electrons forming positive ions.

Construction

- One meter long tube.
- Inside it anode is present & perforated cathode.
- High voltage supply.
- Vaccum pump.
- flourescent material (ZnS).

Mechanism

1- However, in this experiment Scientists did following steps:-
2- Air was removed not completely at desired pressure.
3- A High voltage supply was given to the electrodes.
4- By giving such voltage, gas become ionized, & conductor.
5- As circuit was finished, electricity began to flow.
6- Therefore, electrons were ejecting from cathode plate causing the gas to become ionized.

$$M \longrightarrow M^{+1} + e^-$$

$$He \longrightarrow He^{+1} + e^-$$

7- Since, electrons were also ejecting when pulled over by e⁻g cathode.
8- Those electrons were attracted towards anode.
9- However, ionized particle were attracted towards cathode.
10- Yet, cathode is perforated (has holes). and ionize positive particles are very small & holes are big.
11- Therefore, they gave a canal pathway. To ionize particle
12- As, they pass through those holes.
13- Florscement mateial was present at its wall.
14- When they shiked to the wall, they cause a glowing effect.
15- Giving the proof that positive charge exists.

Q/s

Why positive charges are called 'Canal Rays' so?
These charges / rays are the particle beam ~~emerging~~ that travel in a opposite direction to the 'cathode rays' which are electron waves that more through the anode. These are called canal rays because they passed through holes or canals in cathode.

Properties

Path

1- They travel in a straight path perpendicular to the anode surface.

2- **Electric field**

They can be deflected by electric field.

3- **Deflection**

They are deflected towards cathode that shows that they are positively charged.

4- **Glow**

They produce flash on ZnS plate.

5+6- **E/M ratio**

a) Their ~~e/m~~ $\frac{e}{m}$ ratio is smaller than electron.

b) The $\frac{e}{m}$ ratio depends on nature of gas. The highest $\frac{e}{m}$ is obtained by h_2 gas in tube.

7- **Mass**

The mass of +ve patide is never less than the proton.

8- **Lightest particle**

The positive particle obtained from H_2 gas is the lighest among all +ve particle.

9- **Name**

A particle obtained from positive rays is called proton suggested by Rutherford.

10- **Comparision of Mass**

The mass of proton is 1837 time more than of electron.

27/07/23 Thursday

Discovery Of Neutrons

Discovery

After the discovery of electrons and protons in an atom, nothing extra was known it until 1932. Rutherford in 1920 predicated that some neutral particles must be present in it because he noticed that atomic mass of atoms could not be explained if it were supposed that atoms had only protons & electrons.

History

James Chadwick in 1932 performed an experiment and proved that certain neutral particles also exist in nucleus of an atom & he was awarded Nobel Prize in Physics in 1935 for this discovery.

Experiment

- James fired the α particles from polonium to the target of beryllium.
- As long as it was fired, the radiations start to produce.
- The charge detector detect them as neutral.

Why neutrons were discovered vey late?
Neutron is a neutral body, it couldn't be dedected by magnetic & electric field so it was discovered as eaily as electrons or protons.

Why do neutrons donot have chaige.
The neutrons are made up of three quarks. Two up quarks that are negative -1/3 & -1/3 & 1 down, so it was +2/3. These three when are added, they cancel eachother & make it neutral.

Quarks are small particles (elementay that make neutron & proton. Have flavrs; strange, up & down, charm, botton etc.

31-07-23 Monday:

Unit #02 Rutherford Theory

Discovery

After the discovery of electron, proton & neutron the, next prob was the position of those particle ~~1910~~.

Thus 1910, Rutherford performed an experiment.

Experiment

- Rutherford bombauded the α particles from the platinum & Radium (radio active) on the thin foil of gold about the thickness of 0.00004cm.
- The flowescent screen was covered aound the foil.

Observation

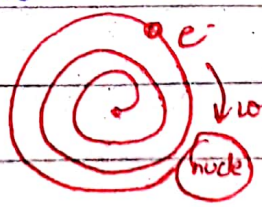
- It was observed that glow occur at some places not all.
- It was meant that all the α particle paused straight through foil except some that were deflected back or deflected to 90°.
- This prove that smth is present inside the foil that deflects the α particle.

Conclusion

- An atom consists of smallest heavy positively charged portion called Nucleus.
- There is negative charged portion around the nucleus containing election called extra-nuclear portion or planetary.
- The number of proton are equal to number of electrons in planetary.
- The electrons revolve around the nucleus.
- The centripetal force is equal to electrostatic force.
- Only very small space is occupied by the nucleus.

Deflect

- Rutherford concept is based on the laws of motion & gravitational force that is applicable to neutral bodies & not on the charged bodies.
- A/o to Maxwell the any charged particles moving in a circular path must radiate energy continuously, ultimately, the electrons must come to spiral around nucleus & atom will collapse.



election more
kata rahey ga energy loss
hogi or woh collapse hojaye ga.

- If a electron emit energy continuously, it should form a continuous spectrum & line spectrum is obtained.

01-August-2023 Tuesday

Bohr's atomic theory

Introduction

In order to remove the defects of Rutherford, a proper internal structure of atom should be studied. A Neil Bohr english scientist proposed another model of atom. Also to thim.

Point

- Electrons revolve around the nuclei in definite energy level known as orbit / shells.
- As long as electron is present in the orbits there's no gain or loss of energy.
- The gain or loss of energy occurs within the shell when electron jump from one energy level to another energy level.
- The angular momentum (mvr) of an electron is equal to $nh/2\pi$.

Angular momentum of an orbit depends upon the no. of quantum number and its an integral multiple of factor $nh/2\pi$. → no. of orbits / shell

$\vec{L} = \vec{P} \times r$

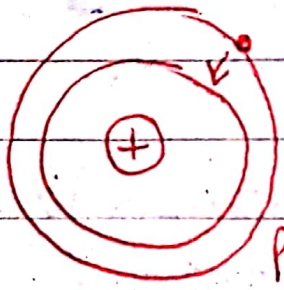
$= mv \times r$

$= mvr$

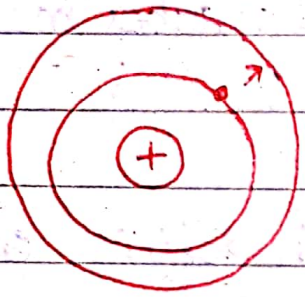
$mvr = \frac{nh}{2\pi}$

→ It is linear motion / circular motion in momentum.

Third point:



ameer to gareeb
so when it travels to that energy
level loss energy.
Process dexitation.



gareeb to ame.
so when it travel to that energy
level gain energy.
Process exitation.

No. of orbit ↑ energy ↑.

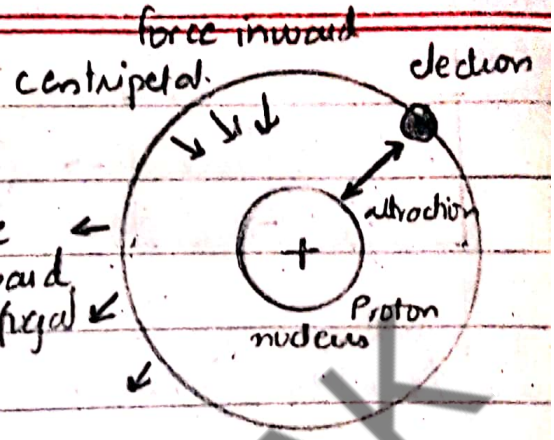
Radius Derivation

expression for the calculation
e atom or ions Like hydrogen,

- Consider, an electron (e^-) revolving around the nucleus having charge Ze^+ where Z, is atomic no. Let m be the mass of electron & v be the velocity of electron revoling around the nucleus. & r be radius of orbit.

Derivation

- Bohr derived an expression for the calculation of the radius of the atom or ions Like hydrogen, lithium, H^+, Li^{+2}.
- Consider, an electron (e^-) revolving around the nucleus having charge Ze^+ where Z, is atomic no. Let m be the mass of electron & v be the velocity of electron revoling around the nucleus. & r be radius of orbit.



A/oto coulomb's law

$$F_c = \frac{kq_1 \times q_2}{r^2}$$

↳ electrostatic constant

$$k = \frac{1}{4\pi\varepsilon_0}$$

$$F_c = \frac{1}{4\pi\varepsilon_0} \times \frac{q_1 \times q_2}{r^2}$$

$q_1 = +q = +e^+$ & $q_2 = -q = -e^-$

$$F_c = \frac{1}{4\pi\varepsilon_0} = \frac{e^+ \times e^-}{r^2}$$

$$F_c = \frac{1}{4\pi\varepsilon_0} \times \frac{e^2}{r^2}$$

$$F_c = \frac{Ze^2}{4\pi\varepsilon_0 r^2}$$

atomic no for identification of an element

A/o to centripetal force.

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

centripetal = electrostatic force

centrifugal = F_c

↓

beloz wana equilib nhi noga toh revolve nhi hoga.

Compare eq (i) & (ii) $mv^2 = \frac{Ze^2}{4\pi\varepsilon_0 r}$

$$\frac{Ze^2}{4\pi\varepsilon_0 r^2} = \frac{mv^2}{r}$$

$$Ze^2 \times r = mv^2 \times 4\pi\varepsilon_0 \times r^2$$

$$r = \frac{Ze^2}{4\pi\varepsilon_0 mv^2}$$

$$r = \frac{Ze^2}{4\pi\varepsilon_0 mv^2} \rightarrow \text{(iii)}$$

no medium b/w proton & e^-

Angular momentum:

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

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

$$v = \frac{nh}{2\pi mr} \rightarrow \text{(iv)} \rightarrow v^2 = \frac{n^2h^2}{4\pi^2m^2r^2} = \left(\frac{nh}{2\pi mr}\right)^2 \text{(iv)}$$

Put eq(iv) in eq(iii)

$$r = \frac{Ze^2}{4\pi\varepsilon_0 mv^2}$$

$$r = \frac{Ze^2}{4\pi\varepsilon_0 m\left(\frac{n^2h^2}{4\pi^2m^2r^2}\right)}$$

$$r = \frac{Ze^2}{\frac{\varepsilon_0 n^2h^2}{\pi mr^2}}$$

$$r = \frac{Ze^2}{\varepsilon_0 n^2h^2} \times \pi mr^2$$

$$\frac{a}{\frac{b}{c}} = \frac{a \times c}{b}.$$

$$r = \frac{Ze^2 m r^2 \pi}{\varepsilon_0 n^2 h^2}$$ can be change.

To memorize the derivation, remember turning point

$$1 = \frac{Ze^2 m r \pi}{\varepsilon_0 n^2 h^2}$$

$$r = \frac{\varepsilon_0 n^2 h^2}{Ze^2 m \pi}$$

Hm isliye ut dain kai rahey hy take akai me sab constant ho or ek ki value change kar sakeye or woh 'n' orbit no,

Z = hydrogen = 1.

$$r = \frac{\varepsilon_0 n^2 h^2}{1 \times e^2 m \pi}$$

$$r = n^2 \times \left(\frac{\varepsilon_0 h^2}{e^2 m \pi}\right)$$

0.529 A°

$a_0 = \frac{\varepsilon_0 h^2}{e^2 m \pi} = 5.29$

constant is called a_0.

$\varepsilon_0 = 8.854 \times 10^{-12}$

$h = 6.626 \times 10^{-34}$ Js.

$e =$ ~~5.4858 × 10⁻⁴ kg~~ 1.60×10^{-19} C.

$\pi = 3.14$ / $22/7$

$m =$ ~~5.4858 × 10⁻⁴~~ 9.11×10^{-31}

$r = n^2 \times 0.529 \times 10^{-10}$ m

10^{-10} m = 1A° (Angstrom.)

$r = n^2 \times 0.529$ A° ~~m~~

for hydrogen n = orbit are 1 so,

$r = (1)^2 \times 0.529$ A°

$r = 0.529$ A°

Derivation of Energy

4-8-23

The energy of electron in an orbit is the sum of:

$E_T = K.E + P.E$

P.E b/w two charges due to charge position.

$\therefore P.E = \frac{kq}{r}$

$r \rightarrow$ distance b/w e^+ & e^-.

proton = Q, electron = q.

$P.E = \frac{1}{4\pi\varepsilon_0} \times \frac{Qq}{r}$ $\quad \because k = \frac{1}{4\pi\varepsilon_0}$

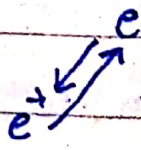
$P.E = \frac{Qq}{4\pi\varepsilon_0 r}$

$P.E = \frac{e \times e^2 \times Z}{4\pi\varepsilon_0 r}$

$P.E = \frac{-Ze^2}{4\pi\varepsilon_0 r}$ direction is opposite (attraction)

K.E = motion of charges

P.E = position of charges



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

$E_T = K.E - P.E$ → opposite direction

$$= \frac{1}{2}mv^2 - \frac{ze^2}{4\pi\varepsilon_0 r}$$

$$= \frac{1}{2}\left(\frac{ze^2}{4\pi\varepsilon_0 r}\right) - \frac{ze^2}{4\pi\varepsilon_0 r} \qquad \because mv^2 = \frac{ze^2}{4\pi\varepsilon_0 r}$$

$$= \frac{1}{2}\frac{ze^2}{4\pi\varepsilon_0 r} \times \left(\frac{1}{2} - \frac{1}{1}\right) \qquad \because \text{common.}$$

$$= \frac{ze^2}{4\pi\varepsilon_0 r} \times \left(\frac{-1}{2}\right)$$

$$= \frac{-ze^2}{8\pi\varepsilon_0 r}$$

$$= \frac{-ze^2}{8\pi\varepsilon_0} \times \frac{1}{r}$$

$$= \frac{-ze^2}{8\pi\varepsilon_0} \times \frac{1}{\frac{ze\,n^2h^2\varepsilon_0}{ze^2m\pi}}$$

$$= \frac{-ze^2}{8\pi\varepsilon_0} \times \frac{1}{\frac{\varepsilon_0 n^2h^2}{ze^2m\pi}}$$

$$= \frac{-ze^2}{8\varepsilon_0} \times \frac{ze^2m}{\varepsilon_0 n^2h^2} \Rightarrow \frac{-z^2me^4}{8\varepsilon_0^2 n^2h^2} \quad \text{eq (i)}$$

$$E_T = \frac{1}{n^2} \times \frac{-mz^2e^4}{8\varepsilon^2h^2}$$

$$E_T = \frac{1}{n^2} \times \frac{-m(1)^2e^4}{8\varepsilon^2h^2}$$

$$E_T = \frac{-me^4}{8\varepsilon^2h^2n^2} \qquad \therefore E_T = \frac{E_n}{\text{orbit no.}}$$

$$E_n = \frac{-me^4}{8\varepsilon^2h^2} \times \frac{1}{n^2} \qquad \frac{me^4}{8\varepsilon^2h^2} = 2.18\times10^{-18}\,J$$

$$E_n = -2.18^{-18} \times \frac{1}{n^2}\,J$$

$$E_n = \frac{-K}{n^2}\,J \qquad -2.18\times10^{-18} = K \;(\text{constant})$$

But if we in no. of atom is present so how much energy is present so,

$$E_n = \frac{-K}{n^2} \times \frac{N_A}{1000}\,KJ/mole^{+1}$$

Likewise, $E_n = \frac{-2.18\times10^{-18}}{n^2} \times \frac{6.023\times10^{23}}{1000}$

$$= \frac{-1313.35}{n^2}\,KJ/mole$$

This energy is associated with 1.008 g atoms of H.

if $n = 1, 2, 3, 4, 5$

$E_1 = -\frac{1313.35}{1^2} =$

$E_2 = -\frac{1313.35}{2^2} = -1313.35$ kJ/mole

$E_3 = -\frac{1313.35}{3^2} = -328.337$ kJ/mole

$E_4 = -\frac{1313.35}{4^2} = -145.927$ kJ/mole -82.08 kJ/mole

$E_5 = -\frac{1313.35}{5^2} = -52.534$ kJ/mole ~~82.08~~

In (-) less no higher, (-) more less no.

E_1 first energy level is gromd level & othe higher than E_1 aie excited states that has high energy

Difference in Energy b/w two orbits

L_2 has high energy ... L_2 has low.

$$\Delta E = \left(\frac{-Ze^4m}{8\varepsilon_0^2h^2n_2^2}\right) - \left(\frac{-Z^2e^4m}{8\varepsilon_0^2h^2n_1^2}\right)$$

$$= \frac{-Z^2e^4m}{8\varepsilon_0^2h^2n_2^2} + \frac{Ze^4m}{8\varepsilon_0^2h^2n_1^2}$$

$$= \frac{Z^2e^4m}{8\varepsilon_0^2n_1^2h^2} - \frac{Ze^4e^4m}{8\varepsilon_0^2n_2^2h^2}$$

Using eq (i)

$E_2 - E_1 = \Delta E$

E_2 has high energy & E_1 has low.

$$\Delta E = \left(\frac{-Ze^4m}{8\varepsilon_0^2 h^2 n_2^2}\right) - \left(\frac{-Z^2e^4m}{8\varepsilon_0^2 h^2 n_1^2}\right)$$

$$= \frac{-Z^2e^4m}{8\varepsilon_0^2 h^2 n_2^2} + \frac{Ze^4m}{8\varepsilon_0^2 h^2 n_1^2}$$

$$= \frac{Z^2e^4m}{8\varepsilon_0^2 n_1^2 h^2} - \frac{Ze^4m}{8\varepsilon_0^2 n_2^2 h^2}$$

$$\Delta E = \frac{mZ^2e^4}{8\varepsilon_0^2 h^2} \times \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

if $H = 1$

$$\Delta E = 2.18 \times 10^{-18} J \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

Derivation for Freqxency

ν → new
↓ frequency

$\nu \nu = f$

$\Delta E = hf$ → represent by $\nu\nu$

$$hf = 2.18 \times 10^{-18} J \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$f = \frac{me^4}{8\varepsilon_0^2 h^2 \times h} \times \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$f = \frac{me^4}{8\varepsilon_0^2 h^3} \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) Hz \text{ or } cycles\,sec^{-1}$$

Wave No

...eney (υ) & wavelength ($\bar{\upsilon}$).

$V = c$

speed of photons = speed of light

$V = \lambda f$

$c = \upsilon\lambda$

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

$\upsilon = c \times \frac{1}{\lambda}$ $\quad \therefore \frac{1}{\lambda} = \bar{\upsilon}$

$\upsilon = c \times \bar{\upsilon}$

$\bar{\upsilon} = c\bar{\upsilon}$

↓ ↓ ↘ no. of wave

f $\quad \upsilon$

$$\frac{z^2 m e^4}{8\varepsilon_0^2 h^3} = c\bar{\upsilon} \times \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] = c\bar{\upsilon}$$

$$\bar{\upsilon} = \frac{z^2 e^4 m}{8\varepsilon_0^2 h^3 c}\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$\frac{me^4}{8\varepsilon_0^2 h^3 c} = 1.09678 \times 10^7\ m^{-1}$ Rydberg's constant.

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

$\bar{\upsilon} = 1.09678 \times 10^7 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] m^{-1}$

Jab e⁻ high energy level se low energy level pr atata hy toh woh photon emit karta hy.

more wavelength less wave no inverse

Small wavelength no of wave ↑

long wavelength no. of wave ↓

7-8-23

Defect of Bohr Model

1- One Electron System

Bohr atomic model is applicable for only one electron system and cannot explain the origin of spectrum of multielectron or polyelectronic system Like He, Li, Be etc.

2- Fine line Spectrum

When spectrum of H_2 gas is seen in spectrometer, the origin of spectral lines are replaced by other fine line, original lines are divided into other fine lines. Bohr theory donot explain this structure.

3- 3D Space

Bohr suggested that circular orbit around the nucleus of H-atom. But it has proved that motion of e^- is not single plan but in 3D space.

4. **Zeeman & Stark Effect**

Bohr theory cannot explain the effect of magnetic field (Zeeman) & electric field (Stark) on the spectra of atom.

5- **Specific Velocity & radii**

Bohr's atomic model is not satisfactory. In Bohr model the electrons in the ~~et~~ orbit ~~have~~ revolve with specific velocities & specific radii. But Heisenberg uncertainty principle says that Both Velocity & exact position of e^- cannot be determined / measured simultaneously.

6- **Wave Equation**

Schrondiger give a wave equation of H-atom. Also to him, the velocity & position of e^- cannot be determined, the probability of finding an e^- is ascertainted.

The maximum distance of finding electron 0.0529nm.

Effect

Zeeman effect

The splitting of spectral lines of H-atom under the influence of magnetic field.

Stark effect

The splitting of spectral lines of H-atom under the influence of E.F.

Spectrum

The visual display or dispersion of light into its component when its passed through prism.

Continuous

When boundary between the electrons colors can't be isolated.

Line

When boundary between the colors can be isolated, marked.

Date = 9th Aug-23

Hydrogen Spectrum

Construction

When Hydrogen is enclosed in a container and heated, it emits the radiation. These raditions are emitted by excitation and de-extiation process.

Equation

$$\bar{v} = R(1.09678)\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] m^{-1}$$

Bohr Concept

Bohr was able to review / predict the wave no in the hydrogen emission spectrum and the transition process (change in energy level) that occur in hydrogen.

Calculation

The wave no. of diff spectral line can be calculated to the corresponding values of n_1 & n_2. In the hydrogen spectrum, diff ~~lines of~~ series of line of n_1 & n_2 can be identified.

Lyman $n_1 = 1$ $n_2 = 2, 3, 4, 5, 6 \infty$

UV radiation.

Balmar $n_2 = 2$ $n_2 = 3, 4, 5, 6 \infty$

visible radiation.

Paschen $n_1 = 3$ $n_2 = 4, 5, 6, 7 \infty$

IR radiation.

Brackett $n_1 = 4$ $n_2 = 5, 6, 7, 8, \infty$

IR types.

Pfund $n_1 = 5$ $n_2 = 6, 7, 8, 9 \infty$

IR types.

Origin discovery

The first spectral lines were observed by Lyman & Balmar in 1887. No satisfactory result were produced. In 1913, Neil Bohr presented the spectral lines.

Construction

1- When the H_2 gas is collected in the discharge tube.
2- The electric spark is passed through the tube and pressured is low.
3- The moleculer start to break into atoms.
4- The atoms absorbed heat.
5- The lower election absorbs heat & possibility to migrate to higher energy level.

6- The process ~~of~~ is exitation.

7- The electrons are unstable at high energy level and when migrate to low energy level, they ~~result~~ release energy which was first absorbed.

8- Diff series of lines were made & their wave number $\bar{\upsilon}$ can be calculated.

Lyman Series

In lyman series, the electrons jump back into $n=1$ level.

The higher level were occupied by spalk.

First line:

$n_1 = 1, \quad n_2 = 2.$

$$\bar{\upsilon} = 1.09678 \times \left[\frac{1}{(1)^2} - \frac{1}{(2)^2}\right] m^{-1} = 82.25 \times 10^5 m^{-1}$$

Second line:

$n_1 = 1, \quad n_2 = 3.$

$$\bar{\upsilon} = 1.09678 \times \left[\frac{1}{1^2} - \frac{1}{3^2}\right] m^{-1} = 97.49 \times 10^5 m^{-1}$$

~~Secor~~ Third line:

$n_1 = 1, \quad n_2 = 4.$

$$\bar{\upsilon} = 1.09678 \times \left[\frac{1}{1^2} - \frac{1}{4^2}\right] m^{-1} = 102.82 \times 10^5 m^{-1}$$

$n_1 = 1$, $n_2 = \infty$

Limiting line: $1.09678 \times \left[\frac{1}{1^2} - \frac{1}{\infty^2}\right] = 109.67 \times 10^5\ m^{-1}$

energy ∞ پر کے Atom ایک یہ کہ مطلب کا Limiting line
کے آخری والا پہنچا ہے اسے ∞ کہتے
ہیں جس میں جو energy جو دے وہ بہت زیادہ ہوتی ہے
release energy ionization وہ energy اور زیادہ ہم دے دیں گے تو
کہ ionize کو e وہ کرے گا جس کی وجہ سے وہ
باہر جا سکتا ہے تو ∞ کے بعد کی series lyman بنتی نکلے گی
کہ آخری ∞ تک نکلے گی۔

Balmar

$n_1 = 2$.

First Line (α) $1.09678 \times 10^7 \left[\frac{1}{2^2} - \frac{1}{3^2}\right] = 15.23 \times 10^5\ m^{-1}$

Second line (β) $1.09678 \times 10^7 \left[\frac{1}{2^2} - \frac{1}{4^2}\right] = 20.56 \times 10^5\ m^{-1}$

Third line (γ) $1.09678 \times 10^7 \left[\frac{1}{2^2} - \frac{1}{5^2}\right] = 23.05 \times 10^5\ m^{-1}$

Fi Limiting line $1.09678 \times 10^7 \left[\frac{1}{2^2} - \frac{1}{\infty^2}\right] = 27.42 \times 10^5\ m^{-1}$

These lines are visible lines & appear closed & grouped formed.

Paschen

$n_2 = 3$

First Line: $1.09678 \times 10^7 \left[\frac{1}{3^2} - \frac{1}{4^2}\right] = 5.33 \times 10^5 m^{-1}$

Second line: $1.09678 \times 10^7 \left[\frac{1}{3^2} - \frac{1}{5^2}\right] = 7.79 \times 10^5 m^{-1}$

Limiting line: $1.09678 \times 10^7 \left[\frac{1}{3^2} - \frac{1}{\infty^2}\right] = 12.18 \times 10^5 m^{-1}$

These are IR & group 5 closed.

Brackett

$n_1 = 4$

First Line: $1.09678 \times 10^7 \left[\frac{1}{4^2} - \frac{1}{5^2}\right] = 2.45 \times 10^5 m^{-1}$

Second Line: $1.09678 \times 10^7 \left[\frac{1}{4^2} - \frac{1}{6^2}\right] = 3.80 \times 10^5 m^{-1}$

Limiting Line: $1.09678 \times 10^7 \left[\frac{1}{4^2} - \frac{1}{\infty^2}\right] = 6.85 \times 10^5 m^{-1}$

Pfund $n_1 = 5$

First line: $1.09678 \times 10^7 \left[\frac{1}{5^2} - \frac{1}{6^2}\right] = 1.34 \times 10^5 m^{-1}$

Second Line: $1.09678 \times 10^7 \left[\frac{1}{5^2} - \frac{1}{7^2}\right] = 2.14 \times 10^5 m^{-1}$

Limiting Line: $1.09678 \times 10^7 \left[\frac{1}{5^2} - \frac{1}{\infty^2}\right] = 4.38 \times 10^5 m^{-1}$

11-Aug-23

Plank's Quantum Theory

Intro

In 1900, Max plank proposed a theory on the natue of light. His theory includes :-

Point

1- **Emission and absorption of photon**

Energy is neither emitted nor absorbed continously. The emission and absorbtion of energy is in the form of wave packets or quanta. In case of Light, the quantum of energy is often called photons.

2- **Energy frequency relation**

The amount of energy is associated with quantum of radiation which is directly proportional to frequency of radiation.

$E \propto \nu$

$E = h\nu$

h is plank's constant, its value is $6.626 \times 10^{-34} Js^{-1}$.

U: Jitni no. of radiations/waves per seccond pas hongi utni hi energy release/absorb hogi.

3- **Integral of Multiple of Quantum**

A body can emit or absorb energy only in terms of integral multiple of Quantum.

$E = nh\nu$ $(n = 1, 2, 3, 4 \ldots)$

$V = f\lambda$

$V = c$, $f = \nu$

$c = \nu \times \lambda$

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

$E = h\nu$ in eq (i)

Put value of ν (f) in (i)

$E = h \times \frac{c}{\lambda}$

$E = hc \times \frac{1}{\lambda}$ $\quad \therefore \frac{1}{\lambda} = \bar{\nu}$

$E = hc\bar{\nu}$

$c \rightarrow$ speed of Light & $\bar{\nu}$ is no. of waves & h is wavelength.

relations

- $E \propto f \nu$

More no. of radiation/waves per sec more energy

- $E \propto \bar{\nu}$

More no. of waves, more energy.

- $E \propto \frac{1}{\lambda}$

larger wavelength, less no. of waves, less energy.

- The no. of waves passing at a point per sec is called ~~wa~~ frequency.
- The distance b/w consective twough, crest is called wavelength.

Value for / Constant for $\bar{v}$

for wave no, the constant unit Angstrom Å is used, as for atomic level, ν & λ are small so it's equal to 10^{-10} m. or nanometer 10^{-9} m.

15th - Aug-23

X-rays

Discovery

Wilhelm Roentgen accidentally discovered the X-rays & labelled as X-rays hence name is not changed yet.

Production

Whenever cathode rays are bombarded (usually a tungsten filament because having good emission of electrons) on any metal surface which is rotating with a certain angle (to avoid scattering of rays and to gather them all in one place to take them and the metal is placed at a certain angle, prevent melting of the metal by constant bombarding at particular point). new energetic radiations are emitted from this metal surface this is because you provide the atoms of metal with a high energy. These radiations are called X-rays.

Window rays

Thus, X-rays are scattered & we want them in a particular place, so we obtained by a hole called as window.

Angle

X-rays jab hum particular angle se produced karwateye hain toh woh diff directions me scattered hojati hy, most of the X-rays obtain karneye ke liye hum certain angle set karteye hy. (45°)

Properties

- These are highly penetrating.
- These have short wavelength, they have high frequency, they have more no. of waves means they are highly energetic.
- Different metals, emit different wavelength of radiations.

Atomic No & X-ray relation

- Moseley took a brief study on X-rays.
- There wavelength mostly are of 0.04Å → 0.08Å.
- Mostly, the frequency of Xrays are changed systematically in periodic table.
- The frequency are directly proportional to the no

of protons (atomic no).

Conclusions

MOselye drew conclusion after detailed analysis of spectral line of X-rays after he tested on 38 diff elements. (AL - Au).

1- Series

The spectral line can be classified into two diff categories :-

- The X-rays belonging to shorter wavelength are called K series.
- The X-rays belonging to longer wavelength are called L-series.

2- Atomic No

If the target metal is of larger atomic no, the X-rays are shorter in length.

3- Relation b/w frequency & atomic no

The relation b/w frequency & atomic no can be explained as:

$\sqrt{v} = a(Z-b)$

a & b are constant quantities.

Moseley Law

"The frequency of the spectral lines in X-rays varies as the square of atomic no of element ~~e~~emitting it."

16th Aug-23

Q. What is Moseley Law? Explain.

Moseley law

It states that:

"Frequency of a spectral line of X-ray spectrum varies as the square of the atomic number of an element emitting it."

description

- Here, the atomic no is only ~~only~~ related to the no. of proton but also the electrons. As no. of proton is always equal to the no. of electrons. therefore, the increase in the atomic no will causes an increase in the no of electron & proton both.
- The binding / electrostatic force of attraction between electrons & proton will be causing the production of energy.
- The more attraction b/w -e & +ve, more energy.
- The less attraction b/w -e & +ve, less energy.
- So, it can be concluded that increase in the no. of electron & proton combingly Atomic no will led to more frequency how?

- When cathode ray will enter the atom & atomic no is greater revising that more e^- so, cathode cathode can knock out more electron outward causing release of radiation.

- $\sqrt{\upsilon} = a(Z-b)$
  a & b proportionality constant.
  $\sqrt{\upsilon}^2 = Z^2$
  $\upsilon = Z^2$
- So, more electrons per second, more wave no, less wavelength leads to more energy.

X-rays, Atomic No, Orbital Structure

In 1913, Henry G.J. Moseley, a student of Rutherford used the technique of X-rays spectroscopy. ~~X-rays are produced in cathode rays tube when electron~~ to determine the atomic no of elements.

U Sabse pehley apne atom per koi bui nazar lagaye betha hy take woh ander jake (inner shells) pr bomb blast kar sakeye. Lihaza woh bahir se aneye wala electron (cathode) ~~tak~~ ghar- lagaye bethtaly, woh jab andar dabang enteg marta hy toh uske sarteye me electron ajata hy chunke

use apna plan secret rakhna tha toh woh andar wale electrons ko dhakelta hy or usey kabar kadeta hy, usey kabar kake woh apni energy gawa deta hy pagal or khud bhi bahir jake mar jata hy. Ab uske upar wala electron creepy smile deta hy ke jaga milgayi, or woh upper se neeche ajata hy ab, kio ke pehley ek atom unstable hogaya tha or ab chunke electron neeche agaya hy toh woh stable hoke ion bangaya or ab us electron ko us shell/orbit ke hissab se zindagi basar karni hy toh woh extra maal (extra e-) ko bahir nikal deyega radiation (X-ray) ki sorat me. joh electromagnetic hongi. This process is called de-extiation process

electromagnetic radiations
Those radiations, waves which donot require any medium & can propogate by themself.

Uses

- X-rays have different penetration power due to different element. However, they cannot pass through metals. This is because when they hit metal surface, they produce electric field which donot allow it to pass. Therefore it can pass through non-conductors. Hence, used for security purpose to photograph interior of object.
- They are used in medical radiography to locate fracture in the bones.
- They by technique of XRD, used to study ~~crystalli-~~ crystalline structure.
- They ionize the gases.

The Quantum Numbers and Orbital

Introduction

Schrondinger in 1926 gave an equation in which electrons are treated as moving with wave like motion in the three dimensionless space around the Nucleus. It differs from the Bohr's atomic model in the sense that the electron move in orbits. It also specifies the distance b/w electron and the nucleus.

Schrondinger Equation

Solution of Schrondinger's wave equation gives certain mathematical integers.

These sets of numerical values, which give the acceptable picture of an atom called Quantum Numbers.

Types

Four types:

- Principal
- Azimuthal
- Magnetic
- Spin.

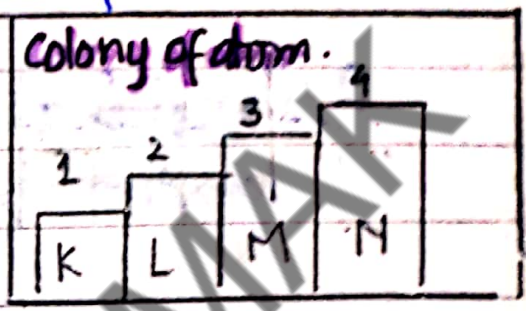
Principle Q. No

- "It determines the size of orbit & distance from nucleus."

$d \propto$ size

Ghar ki Kahani

Colony



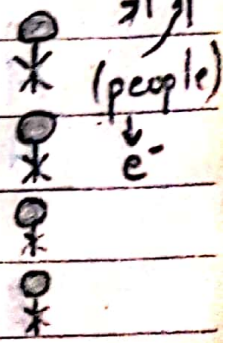
n	1	2	3	4	ghar no
L	K	L	M	N	ghar
	s	s,p	s,p,d	s,p,d,f	ghar ke ander room

n	1	2	3	4	ghar = orbits = shells
L	K	L	M	N	room = orbitals = subshells
	s	s,p	s,p,d	s,p,d,f	

- lauger the distance between e⁻ from nucleus; lauger will be the ~~or~~ size of the orbits.

Determination of e⁻ in ghar/orbits/shell:

n	Ghar	No. of electrons
1	K	$2n^2 \Rightarrow 2(1)^2 = \Rightarrow 2e^-$
2	L	$2n^2 \Rightarrow 2(2)^2 \Rightarrow 8e^-$
3	M	$2n^2 \Rightarrow 2(3)^2 \Rightarrow 18e^-$
4	N	$2n^2 \Rightarrow 2(4)^2 \Rightarrow 32e^-$



- higher the value of n, higher the energy of electron & space around nucleus.

Azimuthal Q No

"It describes the shape of ~~electron~~ orbital."

s = sharp
p = principal
d = diffused
f = fundamental

L=(n-1)	rooms	electrons in room 2(2L+1)
(1-1)=0	s	2[2(0)+1] => 2(0+1) => 2e⁻
(2-1)=1	p	2[2(1)+1] => 2(2+1) => 6e⁻
(3-1)=2	d	2[2(2)+1] => 2(5) => 10e⁻
(4-1)=3	f	2[2(3)+1] => 2(7) => 14e⁻

L = room no & s, p, d, f = room name.

No. of orbits gives no. of orbital.

18-08-23

Quantum No

Azimuthal Quantum No:

The values of L along with orbits are:

Orbits (Ghar)	Orbitals (room & room no)	People(e) in rooms
n=1 (K)	L = (1-1) = 0 ⇒ 0s	s = 2e⁻
n=2 (L)	L = (2-1) = 1 ⇒ 1p, 0s	p = 6e⁻ & s = 2e⁻
n=3 (M)	L = (3-1) = 2 ⇒ 2d, 1p, 0s	p = 6e⁻, s = 2e⁻, d = 10e⁻
n=4 (N)	L = (4-1) = 3 ⇒ 3f, 2d, 1p, 0s	f = 14e⁻, p = 6e⁻, s = 2e⁻, d = 10e⁻
e⁻ of K: 2e⁻	e⁻ of L: 8e⁻	e⁻ of M = 18e⁻ / e⁻ of N = 32e⁻

shapes of orbitals are described by Azimuthal QNO.

s = spherical
p = dumbbell
d = sausage
f = complicated

Magnetic Q/No

It explains the affect of magnetic field on orbital. Related to azimuthal Q No.

equation:

magnetic (m) = $+l \longrightarrow 0 \longrightarrow -l$

Azimuthal & Magnetic

L=s

L=0s it means that an s orbital will remain in its spherical shape. & will not deflect in any direction on placing in magnetic field.

L=p

L=1p. so

(m) = +1, 0, -1

it means that p orbital will ~~n~~ deflect in three directions under effect of M.F. It also mean that p-orbital will split into three degenerative orbitals.

L=d

L=2p. so

(m) = +2, +1, 0, -2, -1

It means that d orbital will deflect in 5 directions under the influence of M.F.

L=f

L = 3f SD

(m) = +3, +2, +1, 0, -3, -2, -1

It concludes that f orbital will deflect in 7 direction under affect of M.F.

Conclusion:

It determines the dimensions & orientation of azimuthal / Quantum no.

22nd Aug-23

Quantum No

Spin Number

It is denoated by s.
It describes the direction of Spin of electron.
In 19205, Goudsmit suggested that: an electron while moving in an orbital around nucleus also rotates or spin on its axis.

Motion

Spin / motion electron is half & half.
The half anticlockwise +1/2. (50%)
The other half is clockwise -1/2. (50%)
Total movement / spin will be 100%.
But net result is zero that means these electron will not collapsed due to anti (up) & clock (down) spin of electrons.

$\uparrow e^- \downarrow e^-$ OR $\uparrow\downarrow$

This rotation is self-rotation.

Association of motion.

The motion of electrons is due to magnetic field & magnetic moment.
As each charged particle (e^-) has its' own

magnetic field.

Charged cloud:

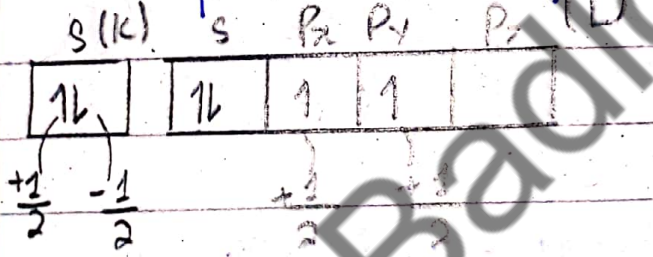
A cloud is showing probability of finding an electron interms of charged cloud around nucleus, is called Electron cloud.

Blue lines are actually orbits.

Example:

Carbon ${}^{12}_{6}C$

~~$1s^2 2s^2 2p^6 3s^2$~~ $1s^2 2s^2 2p^2$



Subshell / Orbital

The circular paths in which e^- revolve around nucleus is called orbits. Inside shells, there is subshells called orbitals.

s-orbitals

s-orbitals are sperical / symmetrical in shape.

U Therefore, Jab ghar no increase (n) [K, L, M, N] hota hy toh unme kamre (room) (subshell) be lauge hojateye hy. Chaheye ~~ghr~~ room ka same rahe

same na ho usme e roum no diff hy or ghai bhi toh usliye subshell increase hotey e /size increase hota hy.

In K shell, s is 1s.

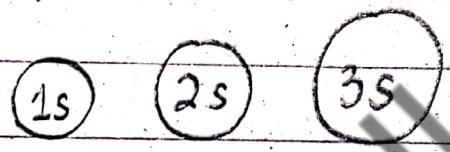
In L shell, s is 2s.

So, 2s > 1s.

Similay

In M shell, s is 3s.

So, 3s > 2s > 1s



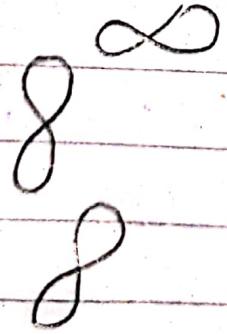
p-orbital

p-orbital is of dumbbell shape. and it has three axises x, y, z. Such an e- orbital move in three directions Px, Py, Pz. These aue (degeenerate orbitals.) → Means their shape is shape but energy is same.

Px

Py

Pz



d-orbital

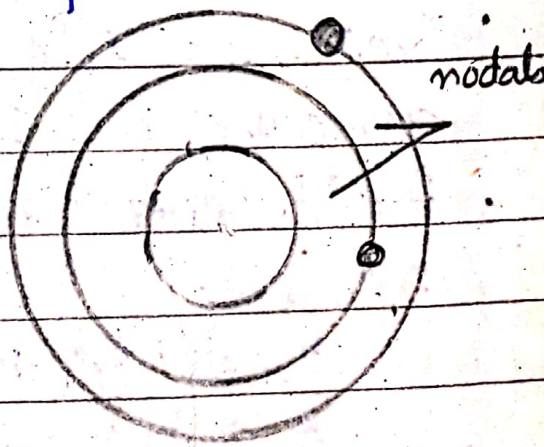
It is also dumbbell shape. And it has five directions: d_{xy}, d_{yz}, d_{xz}, $d_{x^2-y^2}$, d_{z^2}. Such one e^- move in ~~three~~ 5 direction.

f-orbital

It is complex shape. It has 7 directions. Such an e^- move in 7 direction.
very complicated to draw.

nodal plane / nodal surface:

The space region / empty region where e^- can not be found is called ~~nodal~~ nodal plane.



22/08/23

Electronic Configuration

The representation of filling of electrons in different orbitals is called electronic configuration.

energies of orbitals

The energies of orbital depends upon the size of orbital. a/o Principal Quantum.
The trend of energies of orbital is.

$$s < p < d < f$$

Rules:

- Orbitals like Px, Py, Pz, dxy, dyz, dxz, dx^2-y^2, dz^2 can have max $2e^-$ not more than it.
- ~~Ovb~~ The energy in orbit (order) is governed by n+l rule.
  (n → shell (Principle Q.N).
  (l → Orbital (Azimuthal Q.N))
- electron should be in order of increasing energy. First should be lowest. A/o (n+l) rule.
  2s = [n+l] = (2+0) = 2.
  3p = [n+l] = (3+1) = 4.
  2s < 3p so 2s is first filled.

- If n+l rule values are same, then we should fill e^- a/c to their shell no.

$4p = [n+l] = [4+1] = 5$
$3d = [n+l] = [3+2] = 5$

So, whose n= is low/less, The 3d so, its is first added & then 4p.
3d < 4p.

Principles:

Auf-Bau: A German
According to this principle:
"e- electron are placed in subshell according to order of increasing energy."

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

Pauli's:
According to this principle:
"No two electrons in the same orbitals can have same 4 Quantum numbers."

e.g:

$n = 2$.

So,

$n = 2$	$n = 2$
$l = 1$	$l = 1$
$m = +1, 0, -1$	$m = +1, 0, -1$
$s = \frac{+1}{2}$ (1)	$s = \frac{-1}{2}$ (↓)

The max no. of e in an orbital is 2 but they have opposite spin, one is anticlockwise (+), $\left(\frac{+1}{2}\ \uparrow\right)$ & one is clockwise (-) $\left(\frac{-1}{2}\ \downarrow\right)$ So, they complete valency like this (↑↓) but if single e⁻ is present it may be (↑) or (↓).

23/08/23

Hunds Rule

Hund's Rule states or explains:- is
The valency of an element because of unpaired of electrons that actually gives the valency of element.

Explanation:
If degenerate orbitals (orbitals having diff shape but same energy) are present for electrons. So electrons are more likely to fill the orbitals seperately & independently having parallel spin either anticlockwise / clockwise. The arrangements of electrons will be like ↑ ↑ OR ↓ ↓ rather than ↑↓ ○.
This rule is applicable for both hybridized orbitals and molecular orbitals.

unpaired e⁻ make bond

Concept of valency
The single e⁻ present in orbitals to make bonds is called valency.
Molecular orbitals:
1. **Oxygen:** $1s^2 2s^2 2p^4$ O=O

1s	2s	2Px	2Py	2Pz
↿⇂	↿⇂	↿⇂	1	1

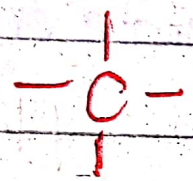
has valency of two to complete octet. So called 'divalent'.

2. Nitrogen: $1s^2 2s^2 2p^3$ $N \equiv N$

1s	2s	2Px	2Py	2Pz
↿⇂	↿⇂	1	1	1

has valency of three to complete octet. So called 'trivalent'.

3. Carbon: $1s^2 2s^2 2p^2$



1s	2s	2px	2py	2pz
↿⇂	↿⇂	1	1	

has valency of 4 in 2px one valency, in 2py one valency & in 2pz 2 valency ~~total~~ 4 valency so 'tetravalent' but it seems to be divalent due to 2px & 2py.