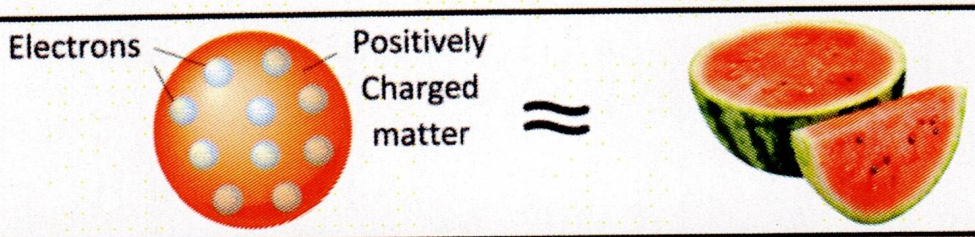
STRUCTURE OF ATOM

ATOMIC MODELS

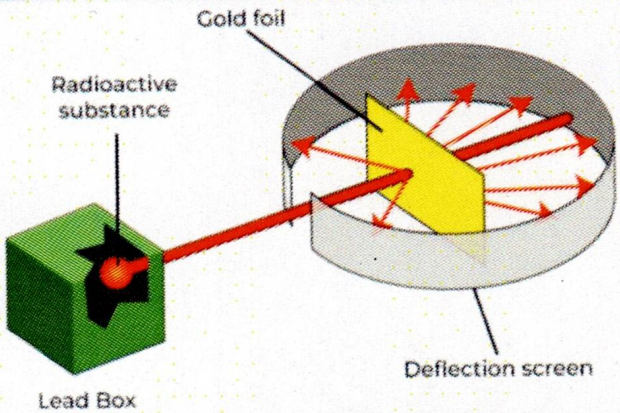
THOMSON ATOMIC MODEL (Plum/Watermelon)

- Atom is like a sphere with a radius of approx 10^{-10}m
- Positive charge uniformly distributed.
- Electrons under stable electrostatic arrangement.



RUTHERFORD'S ATOMIC MODEL

- Most of the space in the atom is empty.
- The positive charge is concentrated in a very small volume.



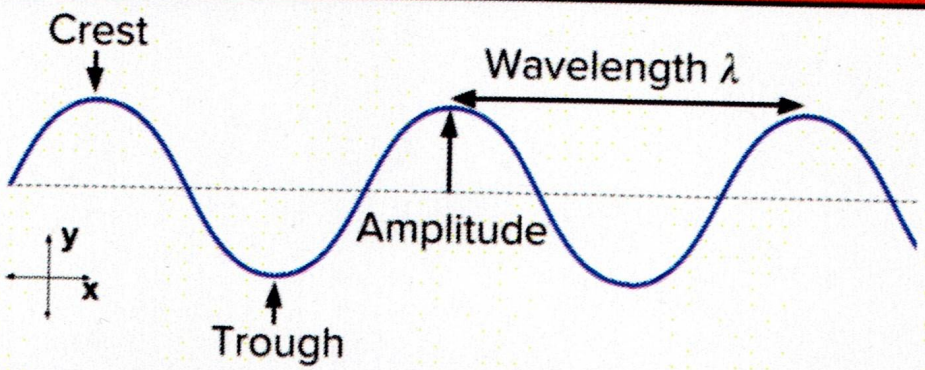
- The volume of the nucleus is very small compared to the total volume of the atom.

Rutherford model not in accordance with maxwell theory, did not explain stability of atom and arrangement of electrons inside atom

Important terms

Isoelectronic : Same no. of electrons	CH_4, NH_3, H_2O
Isotopes : Same atomic no. different mass no.	${}_1H^1$, ${}_1H^2$, ${}_1H^3$
Isobars : same mass no. different atomic no.	${}_{18}Ar^{40}$, ${}_{20}Ca^{40}$
Isotones : same number of neutrons	${}_6C^{13}$, ${}_7N^{14}$
Isosters : Same number of electrons and atoms.	CO_2, N_2O
Isodiaphers : Same number of neutrons-protons.	${}_1H^3$, ${}_5B^{11}$

Waves and their characteristics



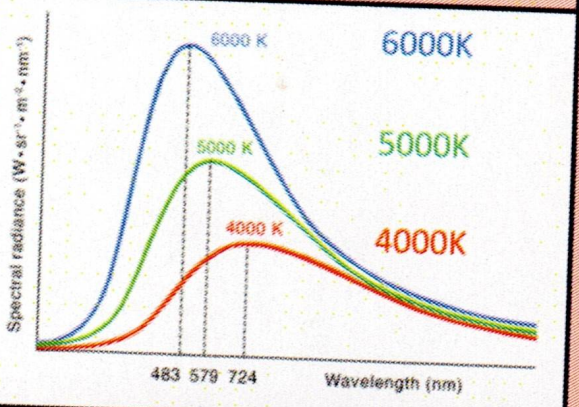
Frequency (v) : Number of cycles per second (Hz or s^{-1})

Wave number : Number of waves per unit time (cr

Particle nature was result of

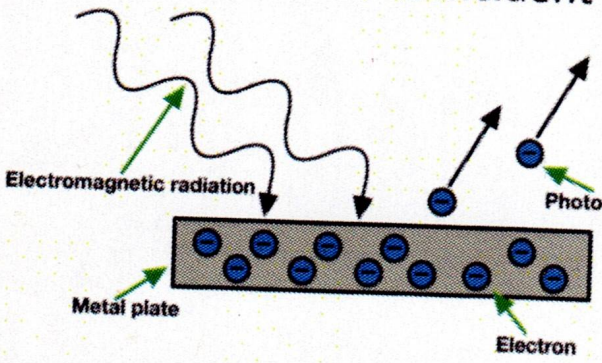
Black Body Radiations

The ideal body which emit and absorbs all the frequencies is called Black body and the radiation emitted by such body is called Black body radiation.



Photoelectric Effect

Emission of electron from the surface of metal when a photon of certain v is incident to metal surface.



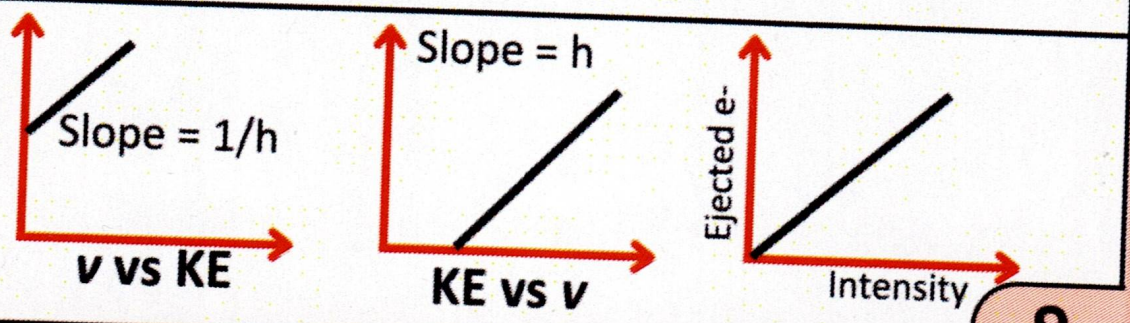
$$h\upsilon = h\upsilon_o + 1/2\, mv^2$$
$$h\upsilon = w_o + 1/2\, mv^2$$

w_o = Work Function

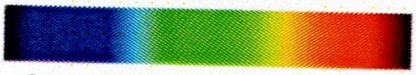
v_o = Threshold Freq.

After Threshold, **it's all Kinetic Energy**

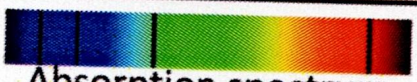
- No. of Photoelectrons $\propto$ Intensity of Light
- Kinetic Energy $\propto$ Frequency of Light



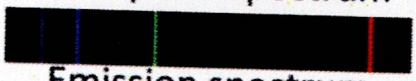
Emission Spectrum of Hydrogen Atom



Continuous spectrum



Absorption spectrum



Emission spectrum

$$\overline{\nu} = \frac{1}{\lambda} = R_H \left[\frac{1}{{n_1}^2} - \frac{1}{{n_2}^2}\right] \times Z^2$$

n_1 & n_2 = energy levels of transitions
R_H = Rydberg Cosntant
Z = atomic number

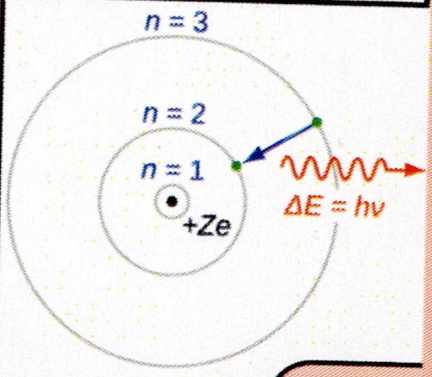
Number of Spectral Lines	$\frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2}$

Spectrum Lines of Hydrogen Atom

Series	n_1	n_2	Spectral Reg.
Lymann	1	2,3..	U.V.
Balmer	2	3,4..	Visible
Paschen	3	4,5..	IR
Brackett	4	5,6..	IR
Pfund	5	6,7..	IR

Bohr's Theory

- Electron in circular orbits
- Energy of electron doesn't change in an orbit.
- Energy is absorbed or emitted in the difference of $\Delta E = h\nu = hc/\lambda$



Bohr model Formulas

Angular Momentum is quantised; n = 1,2,3...	$mvr = n\frac{h}{2\pi}$
Bohr's Radius	$r_n = 0.529 \times \frac{n^2}{Z}\ A^\circ$
Energy of Electron **T.E. = -K.E. = P.E/2**	$E_n = -13.6 \times \frac{Z^2}{n^2}\ eV$ $E_n = -2.18 \times 10^{-18} \times \frac{Z^2}{n^2}\ J$
Velocity of Electron	$v_n = 2.18 \times 10^6 \frac{Z}{n}\ m/s$

Time period	$T \propto \frac{n^3}{Z^2}$	**Frequency**	$\propto \frac{Z^2}{n^3}$

De-Broglie Hypothesis

$$\lambda = \frac{h}{p} = \frac{h}{mv} = \frac{h}{\sqrt{2m(KE)}} = \frac{h}{\sqrt{2mqV}} = \frac{12.24}{\sqrt{V}}\ A^\circ$$

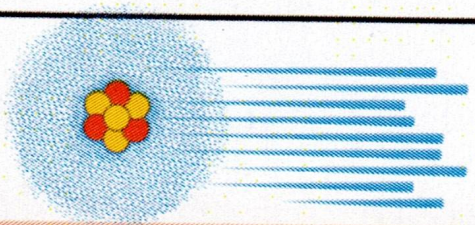
V = Potential; q= charge; KE = Kinetic Energy

Heisenberg Uncertainity Principle

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

Δx = Change in Position

Δp = Change in Momentum



Quantum Mechanical Model (Schrodinger)

$$\frac{d^2\Psi}{dx^2}+\frac{d^2\Psi}{dy^2}+\frac{d^2\Psi}{dz^2}+\frac{8\pi^2 m}{h^2}(E\text{-}V)\Psi = 0$$

ψ = Wave function is just a mathematical function and it has no physical significance.

ψ^2 = The probability of finding electron at a point within an atom is proportional to $|\psi^2|$ at that point. It is known as probability density.

Region where probability is maximum is **Orbital**

Quantum Numbers

Principle quantum number (n)

- Positive integer with values n = 1,2,3,4..
- n denotes the **shell number, energy of electron, size of the shell.**
- Maximum number of electron in shell = $2n^2$
- Maximum number of orbitals in shell = n^2

Azimuthal Quantum number (*l*)

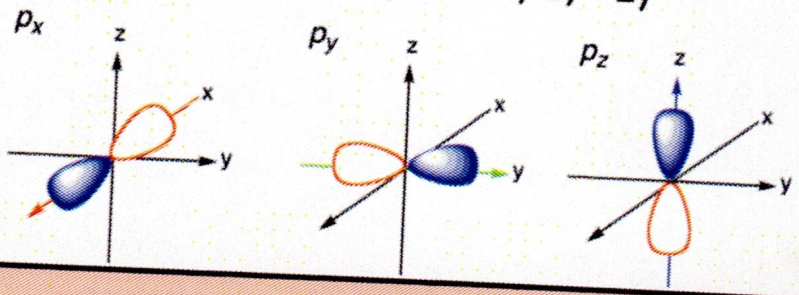
- Positive integer with values *l* = 0,1,2,3,..
- *l* denotes the **subshell, suborbit, sub energy level.**
- value of *l* ranges from 0 to n-1

l	0	1	2	3
orbital	s	p	d	f

Magnetic quantum Number (m)

- Positive integer depending upon value of *l* as m ranges from -*l* to +*l* (total = 2*l*+1 values)
- It tells about the orientation of the orbital.

eg : p orbital has *l* = 1 (m = -1, 0, +1)

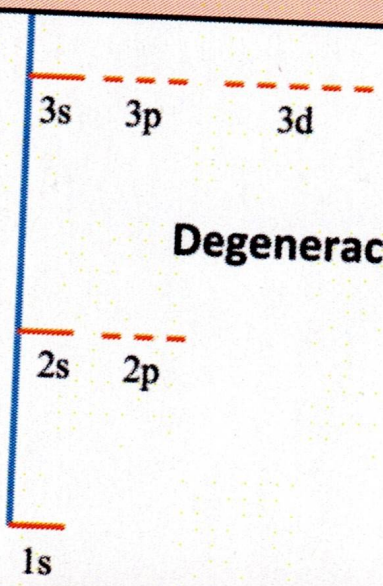


Spin Quantum Number (s)

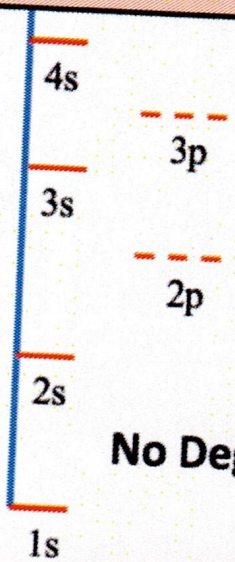
- Electron rotates on its own axis in clockwise or anticlockwise direction. So the spin quantum number can have two values of +1/2 and -1/2.

Energy in different electron systems

Monoelectronic



Polyelectronic



Bohr-Bury rule

- Higher the value of n+*l*, higher is the energy.
- If n+*l* is same for two orbitals, higher the value of n, higher is the energy.

Exceptional electronic configuration

- Chromium : $[Ar]4s^1 3d^5$ (Half Filled configuration)
- Copper : $[Ar]4s^1 3d^{10}$ (Fully Filled configuration)

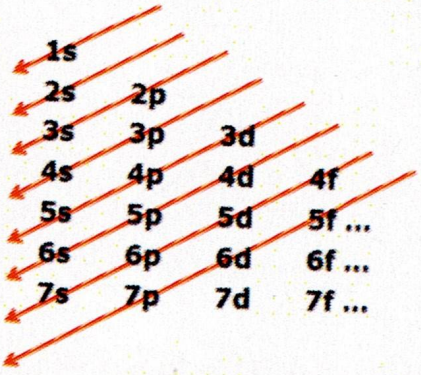
Above electronic configuration is more stable due to **Exchange energy** or **Symmetric distribution of electrons.**

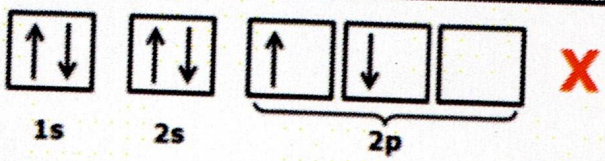
Electronic configuration rules

Aufbau Principle : Electrons filled into atomic orbitals in the increasing order of orbital energy level.

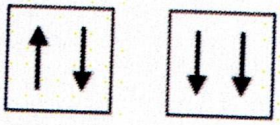
Hunds Rule : Before the double occupation of any orbital, every orbital in the sub level is singly occupied.

Pauli's Principle : In single atom no two electrons will have an identical set or the same quantum numbers (n, l, m, and m.).





X



Incorrect