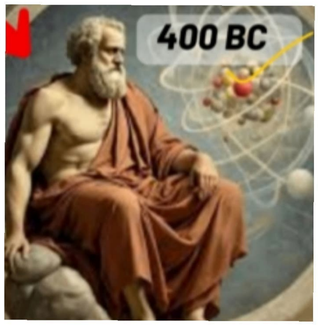
STRUCTURE OF ATOM

ATOM IS INDIVISIBLE

Dalton's Atomic Theory
(around year 1800)

Matter is made of tiny *indivisible* particles called Atoms

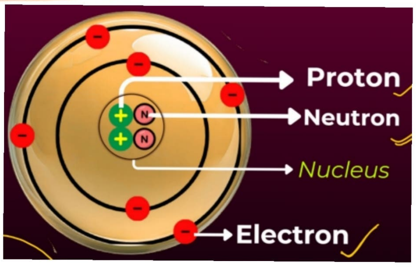
Greek philosphers
Democritus and leucippus
Atom (meaning *indivisible*)



Maharishi kanad
smallest particle, parmanu
can not be divided

Atom is Divisible ⟶ sub-Atomic particles

year 1932



Canal Rays

1886

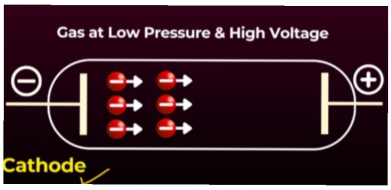
1. E. Goldstein discovered positively charged rays in a tube with gas molecules, that looks like coming from Anode ⟶ Anode rays
2. canal rays are made of positively charged particles ⟶ lead to discovery of proton

Cathode Rays

1897

1. J.J Thomson studied negatively charged rays in a tube with gas molecules, coming from cathode → cathode rays

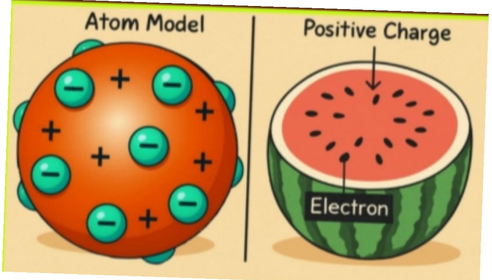
Cathode Rays are made of Negatively charged particles ⟶ Electrons

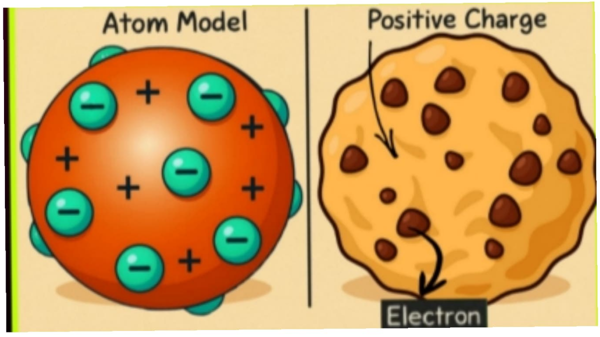


Thomson's Model of an Atom :-

Model of Atom similar to Watermelon -

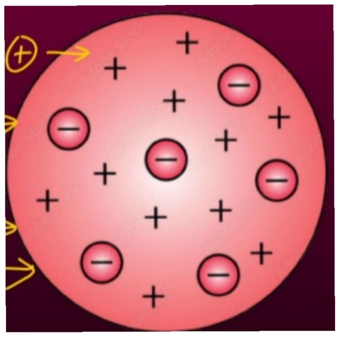
1. Positive charge spread all over → like Red edible part
2. Electrons studded/embedded ⟶ Black seeds.





Model of Atom similar to pudding → plum
- pudding Model :-
1. positive charge spread all over → pudding
2. Electrons studded/embedded → bits of plum or Dry fruits

Thomson proposed :-



(i) An atom consists of a positively charged sphere and the electrons are embedded in it.
(ii) The negative and positive charges are equal in magnitude, so, the atom as a whole is electrically neutral.

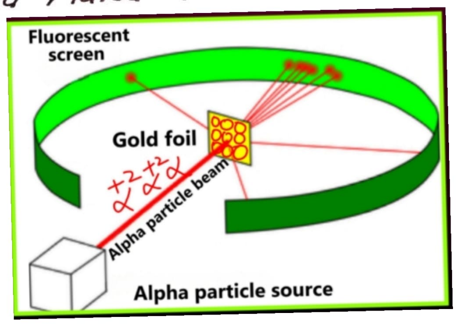
Drawbacks/limitations of Thomson's Model of Atom

Thomson's model of Atom failed to explain the result of experiments carried out by other scientists, such as Rutherford's Gold foil experiment. Hence it was rejected.

Rutherford Alpha Particles Scattering Experiment (or Gold foil Experiment)

year 1909

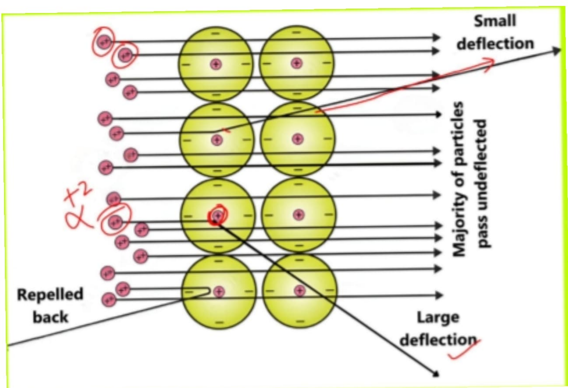
A series of experiments conducted by Geiger and Marsden under the direction of Ernst Rutherford.



- Alpha particle - α

1. Double charged Helium ion → He^{2+}
2. Mass = 4u → fast moving, with large amount of energy

observations



(i) Most of the α-particles (99%) passed straight through the gold foil.
(ii) some of the α-particles were deflected by small angles.
(iii) Very few (one out of every 12000 α-particles) particles rebounded. i.e deflected by 180

Conclusions

(i) Most of the space inside Atom is empty - because most of the α-particles passed through the gold foil without getting deflected.

(ii) Discovery of Nucleus – positive charge of the atom occupies very little space as only some α-particles were deflected from their path. (1 out of 100)

(iii) Size of Nucleus is very small – A very small fraction of α-particles were deflected by 180°. so the entire positive charge is concentrated in a very small space. Radius of the Nucleus is about 10^5 times less than the radius of the atom.

(iv) Mass Concentrated in Nucleus - α-particles are heavy (4u), to rebound them at 180°, there must be something very heavy inside atom.

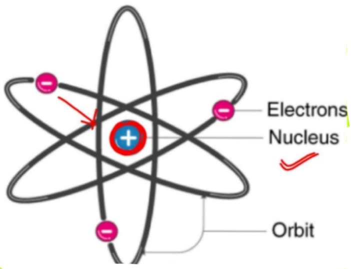
Rutherford's Nuclear Model of an Atom

year 1911

(I) There is a positively charged centre in an atom called the Nucleus, proton is present in Nucleus. Nearly all the mass of an atom resides in the nucleus.

(ii) The electrons revolve around the nucleus in circular paths.

(iii) The size of the nucleus is very small as compared to the size of the atom



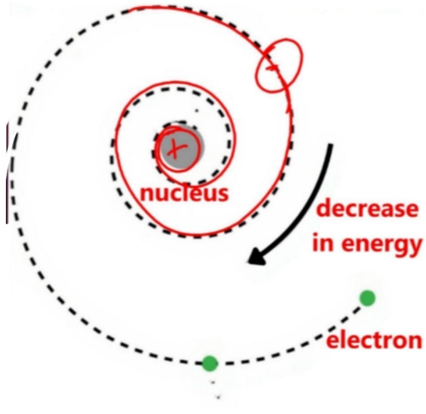
Electrons revolving around Nucleus like planets revolve around sun → Planetary model.

Drawback/limitation of Rutherford's Model of Atom

it cannot explain the stability of Atom

- According to Maxewell's theory any accelerated charged particles loses energy in form of radiations.
- An electron revolves in circle, so its direction of velocity is continuously changing, hence it is accelerated.
- So a revolving electron would lose energy in form of radiations and should spirally fall into the nucleus.
- Thus atom should be highly unstable and hence matter would not exist.

But, we know that atoms are stable.

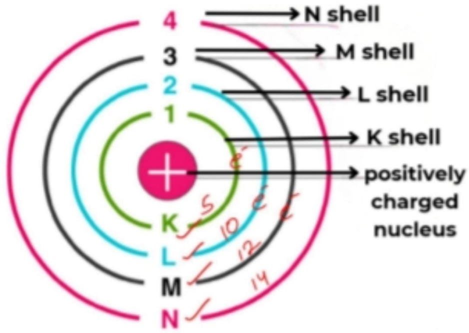


⊖ ⟶ velocity change acceleration

Bohr's Model of Atom

(i) Electron can not revolve in any circular orbit around Nucleus.

(ii) Electrons revolve only in certain fixed orbits around the Nucleus, called Discrete orbits.



(iii) Each Discrete orbits has a fixed energy. These orbits are also called energy levels or Energy shells. The Orbits or Energy level are represented by the letters K, L, M, N - - or the numbers, n = 1, 2, 3, 4 - -

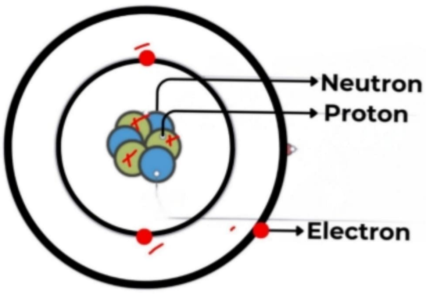
(IV) While revolving in a particular Energy level, an electron has fixed energy. it neither loses nor gains energy in form of radiation

Bohr Just improved Rutherford model of Atom.

Discovery of Neutron and updated Atomic model

Year 1932

- In 1932, James chadwick discovered Neutron.
- Neutron has zero charge.
- Mass of Neutron is nearly equal to that of a proton.
- Neutrons are present in the Nucleus alongwith protons.

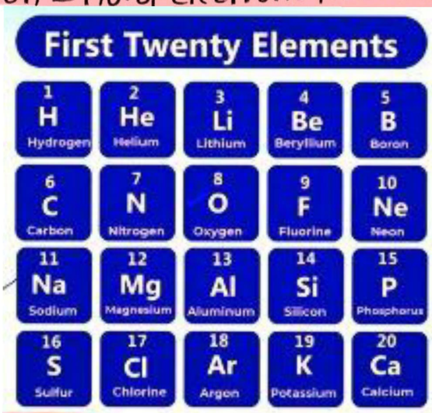


ATOMIC NUMBER (Z) = Element ki pehchan

The Number of protons in Nucleus of an atom is called it's Atomic Number (Z)

- Atomic Number (Z) is the identity of an element
- Atomic Number is changed, Element is changed.
- Note - for a neutral atom

  Z = no. of proton = no. of electrons in atom

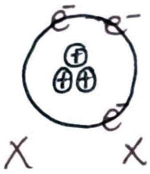


First Twenty Elements

1 H Hydrogen	2 He Helium	3 Li Lithium	4 Be Beryllium	5 B Boron
6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon
11 Na Sodium	12 Mg Magnesium	13 Al Aluminum	14 Si Silicon	15 P Phosphorus
16 S Sulfur	17 Cl Chlorine	18 Ar Argon	19 K Potassium	20 Ca Calcium

First Twenty Elements (2)

Z		Z	
1. Hydrogen (H)	Hi	11. Sodium (Na)	Na
2. Helium (He)	Hello	12. Magnesium (Mg)	Mango
3. Lithium (Li)	Little	13. Aluminum (Al)	Alladin
4. Beryllium (Be)	Bhole	14. Silicon (Si)	Se
5. Boron (B)	Baccho	15. Phosphorus (P)	PePsi
6. Carbon (C)	C (see)	16. Sulfur (S)	Soda
7. Nitrogen (N)	Netflix	17. Chlorine (Cl)	Cola
8. Oxygen (O)	On	18. Argon (Ar)	Aur
9. Fluorine (F)	Friday	19. Potassium (K)	Kaju
10. Neon (Ne)	Night	20. Calcium (Ca)	Catli



Distribution of electrons in different orbits/shells

Bohr–Bury Rule :– Rules for filling electron in shells

1. The maximum number of electrons present in a shell is given by the a $2n^2$ where 'n' is the shell/orbit number.

Orbit (n)	Maximum no. of electrons ($2n^2$)
n = 1 (K - Shell)	$2(1)^2 = 2$
n = 2 (L- Shell)	$2(2)^2 = 8$
n = 3 (M- Shell)	$2(3)^2 = 18$
n = 4 (N- Shell)	$2(4)^2 = 32$

Learn

2. The maximum number of electrons in the outermost shell of atom can not be greater than 8 even if it has capacity to have more electron.
3. The maximum number of electrons in outermost shell can not be greater than 2. unless inner shells are completely filled. (Not needed for first 20 elements)

Name of Element	Symbol	Atomic Number (Z)	No. of Protons	No. of Electrons	Electronic Configuration K	L	M	N	Valency
Hydrogen	H	1	1	1	1				1
Helium	He	2	2	2	2				0
Lithium	Li	3	3	3	2	1			1
Beryllium	Be	4	4	4	2	2			2
Boron	B	5	5	5	2	3			3
Carbon	C	6	6	6	2	4			4
Nitrogen	N	7	7	7	2	5			3
Oxygen	O	8	8	8	2	6			2
Fluorine	F	9	9	9	2	7			1
Neon	Ne	10	10	10	2	8*			0

DUPLET

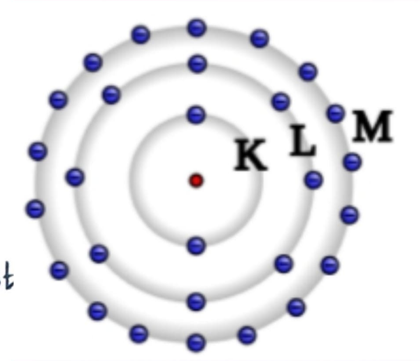
Name of Element	Symbol	Atomic Number (Z)	No. of Protons	No. of Electrons	Electronic Configuration K	L	M	N	Valency
Sodium	Na	11	11	11	2	8	1		1
Magnesium	Mg	12	12	12	2	8	2		2
Aluminium	Al	13	13	13	2	8	3		3
Silicon	Si	14	14	14	2	8	4		4
Phosphorous	P	15	15	15	2	8	5		3
Sulphur	S	16	16	16	2	8	6		2
Chlorine	Cl	17	17	17	2	8	7		1
Argon	Ar	18	18	18	2	8	8		0
Potassium	K	19	19	19	2	8	8	1	1
Calcium	Ca	20	20	20	2	8	8	2	2

ELECTRONIC CONFIGURATION

The arrangement of electrons in the various shells or energy leavels of an atom such as K shell, L shell, M shell, etc.

Valance shell - outermost shell

Valence electrons - The electrons present in outermost shell of atom are known as valence electron.



Atomic structure of first 18 elements

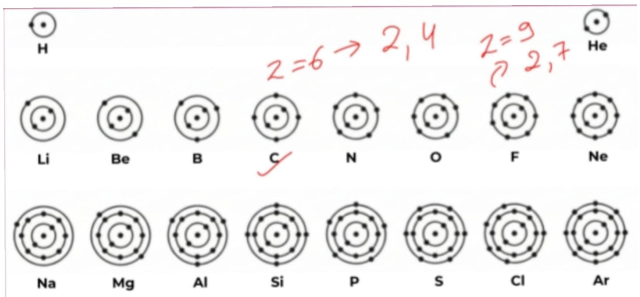


Fig.4.4: Schematic atomic structure of the first eighteen elements

Stable Electronic Configuration

Octet rule :-

- Elements with 8e⁻ in outermost shell (completely filled outermost shell) are very stable and show less reactivity.
- Example - Neon (Ne) → 2, 8
  Argon (Ar) → 2, 8, 8
- Atoms of all other elements want to achieve this octet in their outermost shell to get stability.
- Exception - H, He, Li, Be, B → stable with 2e⁻ in outermost shell (duplet)

Valency

- The number of electrons gained lost or shared by an atom so as to have octet (8 electrons) in the outermost shell is called valency.
  Exceptions :- Elements like H, He, Li, Be B aim for 2 electrons (duplet rule) → (write all valencies on previous table now)
- When Atom lose or gain electron they form charged ions
  Example
  1) chlorine (Cl) 2) sodium (Na), Z=11
  Z = 17

(Neutral Atom) Cl 2, 8, 7 (K L M) $\xrightarrow[\text{gain}]{+e^-}$ Cl^- 2, 8, 8 (K L M)

Na 2, 8, 1 (K L M) $\xrightarrow[\text{lose}]{-e^-}$ Na^+ 2, 8 (K L) ~~M~~

Mass Number

The sum of total number of protons and total no. of neutrons in the nucleus of an atom.

Mass Number (A) = no. of protons + No. of neutrons
= No. of Nucleons

Relationship between Mass No. (A) and Atomic No. (Z)

A = No. of protons + No. of neutrons
Z = No. of protons
A − Z = no. of neutrons

A − Z = N
(A: Mass No., Z: Atomic No., N: No. of Neutrons)

Representation:

Mass No. (A) (proton + Neutrons) ← 12
C
Atomic No (Z) (protons) ← 6

Neutrons = 12 − 6
= 6

$^{A}_{Z}X$ → element

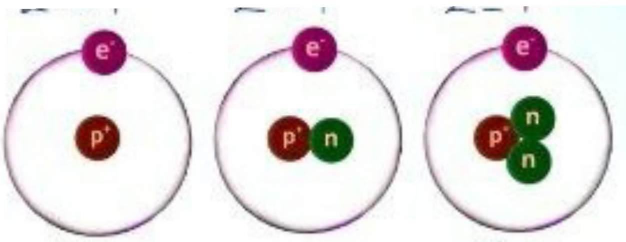
Isotopes

isotopes are atoms of the same element that have the same atomic number (Z) but different mass number (A).

Example – Three Isotopes of hydrogen

	$^{1}_{1}H$ Protium	$^{2}_{1}H$ Deuterium	$^{3}_{1}H$ Tritium
Atomic No. (Z)	1	1	1
Mass No. (A)	1	2	3
No. of Protons	1	1	1
No. of Electrons	1	1	1
No. of Neutrons	0	1	2

A = 1, Z = 1 A = 2, Z = 1 A = 3, Z = 1



chemical properties :– isotopes have the same atomic number and valence electrons, hence they have similar chemical properties as chemical properties depend on electronic configuration or valence electrons

Physical properties :– isotopes differ in mass numbers, hence different physical properties as physical properties depend on mass.

Application of isotopes

1. An isotopes of uranium is used as fuel in nuclear reactors.
2. An isotopes of cobalt is used in the treatment of cancer.
3. An isotopes of iodine is used in the treatment of goitre

Fractional Atomic Mass → existence of isotopes

$^{35}_{17}Cl$ Mass = 35u — 75%

$^{37}_{17}Cl$ Mass = 37u — 25%

$$\text{Avg. Atomic mass} = \left(35 \times \frac{75}{100} + 37 \times \frac{25}{100}\right)$$

$$= 35.5u$$

Isobars

isobars are atoms of different elements with different atomic Numbers but same mass number

$^{40}_{18}Ar$ and $^{40}_{20}Ca$

isobars have different atomic numbers so they are different elements with different electronic configuration, hence different chemical properties.

Isotopes	Isobars
1. Atoms of same element	1. Atoms of different elements
2. Atoms have same Atomic Number (Z)	2. Atoms have different Atomic Number (Z)
3. Atoms have different Mass Number (A)	3. Atoms have same Mass Number (A)
4. Have similar chemical properties	4. Have different chemical properties
5. Ex: Isotopes of Hydrogen	5. Ex: Argon and Calcium
^{1}H, ^{2}D, ^{3}T	$^{40}_{18}Ar$, $^{40}_{20}Ca$