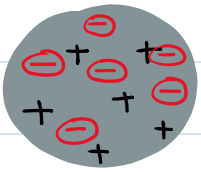
Unit 1 : Atomic Structure

1.1 The atomic theory of matter

- Empedocles 
- Democritus - Invisible, indivisible particle (atom) 
- Plato and Aristotle - No such thing as invisible, indivisible particle 
- John Dalton - Golf ball model 
  - Dalton's postulates
  - Elements are made out of atoms / Invisible Indivisible particle
  - Atoms of same element are identical (mass and size)
    - Ex: Gold (Au)  Two atoms are identical
  - Atoms of different elements are different
    - Ex: Gold and copper (Cu)  Au Cu Two atoms are different
  - Atoms are neither created nor destroyed
    - Ex: $H + H \longrightarrow H_2$ $H + H \not\longrightarrow O_2$
  - Atoms of different elements combine in simple ratio to make compounds
    - Ex: $C + O_2 \rightarrow CO_2$ [C:O 1:2] $C + O \rightarrow CO$ [C:O 1:1]
- Johnstone G. Stoney - Named the fundamental unit carrying electricity as "electron"

- William Crookes - Crookes tube / cathode ray tube experiment.



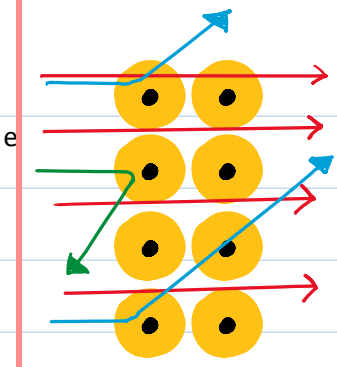
- J. J. Thomson - Plum pudding model
  - Cathode rays are negatively charged particles
  - Cathode rays have a mass and kinetic energy
  - Cathode rays travel in straight lines
  - e/m ratio of cathode ray particle = $1.76 \times 10^{8}\ Cg^{-1}$
  - Properties of cathode rays does not depend on cathode material or gas inside the tube.

- Robert Millikan - Charge of electron = $1.602 \times 10^{-19}\ C$
  mass of electron = $9.10 \times 10^{-28}\ g$

- Eugen Goldstein - Existance of positive charge in matter
  - Canal rays / positive rays / Anode rays
    - Travel in straight lines
    - kinetic energy
    - positive charge
    - e/m ratio is NOT constant

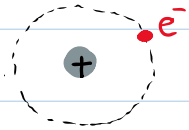
- Henri Becquerel - Radioactivity

- Ernest Rutherford α, β, γ rays
  - Gold foil experiment

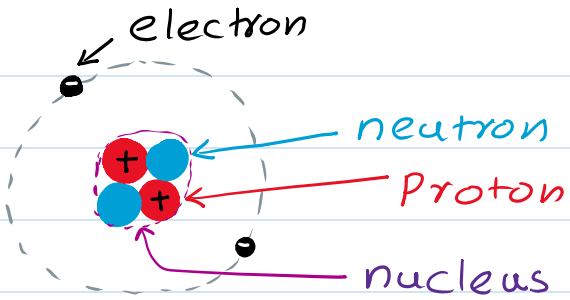


Observation	Conclusion
Majority of particles Penetrated	most of the atom is empty space
Few particles diffflected with large angle	positively charged nucleus
very few particles bounced back	Positively charged mass

- James Chadwick - Neutron



- Niels Bohr - Bohr model (Rutherford-Bohr model)
  Electrons are in orbits
- Henry Moseley - Number of + charges in nucleus increase by single electron unit.
- Max planck - Energy is quantized
- Albert Einstein - Energy exist as tiny packets (photons)
- Louis de Broglie - Under appropriate conditions, particles can behave like waves and waves can behave like particles.



Nucleon = Subatomic Particles

Ex: Protons, neutrons

- Atomic Symbol

A ← Mass number (Protons + neutrons)

X ← Symbol of element

Z ← Atomic number (number of protons)

Ex:

$^{12}_{6}C$

$$A = Z + \text{number of neutrons}$$

- Isotopes: Same Z, different A
  - → Stable isotopes
  - → Unstable isotopes (radioisotopes)

- Atomic mass scale

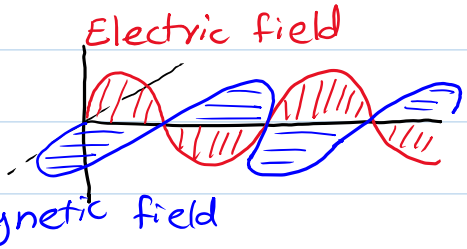
→ Unified atomic mass unit (u) = $\frac{\text{one atom of } ^{12}C \text{ isotope}}{12}$

→ Average atomic mass = Σ (Isotope mass) × (Fractional isotope abundance)

→ Relative atomic mass (A_r) → ratio of average mass and unified atomic mass unit. Dimentionless quantity

- Ions
  - Cations: + Charges Ex: Na^+ Ca^{2+} NH_4^+
  - Anions: − Charges Ex: Cl^- S^{2-} PO_4^{3-}

1.2 Electromagnetic radiation and wave like properties of matter



Electromagnetic waves

→ Speed of light in vacuum

→ perpendicular electric and magnetic fields

$$c = \lambda\nu$$

$$E = h\nu$$

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

c = speed of light ($3 \times 10^8\ ms^{-1}$)

λ = wavelength (m)

ν = Frequency (Hz or s^{-1})

E = Energy of a quantum/photon

h = Planck constant ($6.626 \times 10^{-34}\ Js$)

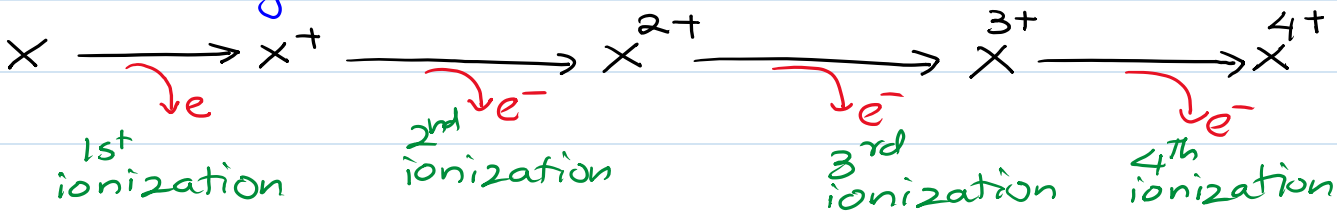
p = momentum

m = mass

V = Velocity

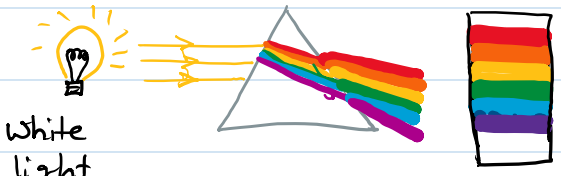
$\lambda\uparrow \Rightarrow \nu\downarrow \Rightarrow E\downarrow$

- Ionization energy: Minimum energy required to remove an electron from the ground state of isolated gaseous atom or ion.



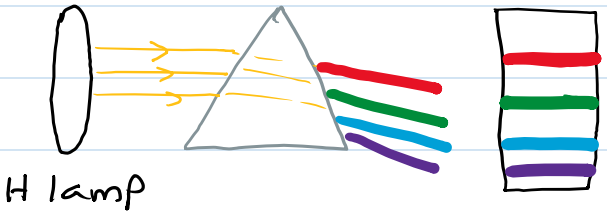
- Sharp increase in ionization energy is an evidence of the fact that electrons are in discrete energy levels.

Continuous spectra

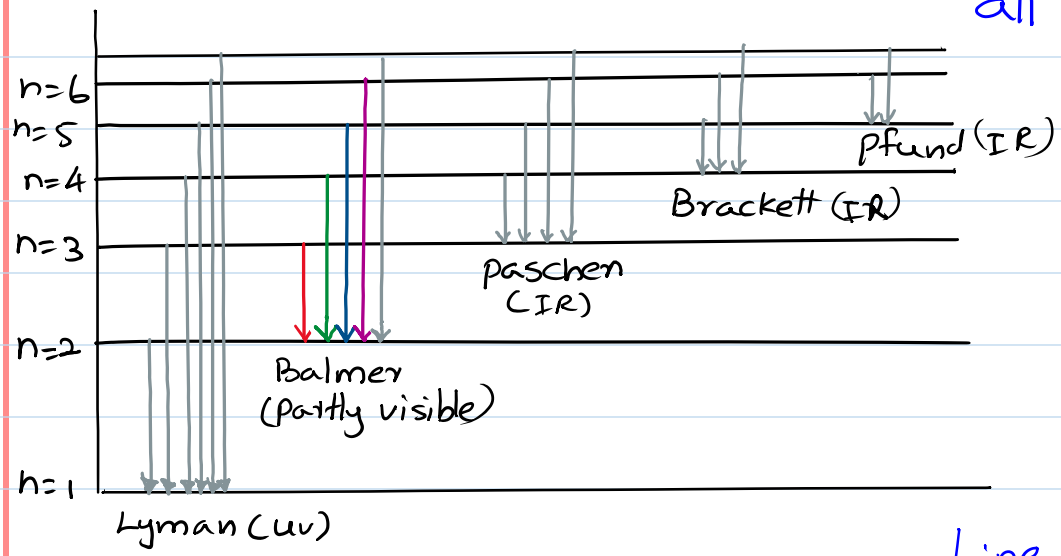


all λ present

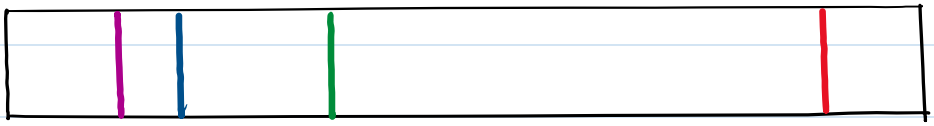
Line Spectra



all λ not present



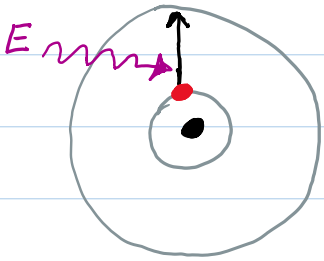
Line spectrum of H



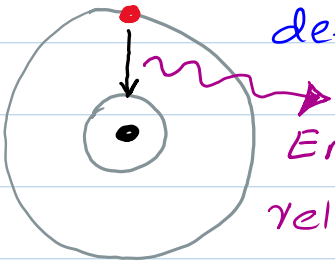
small λ
high ν

large λ
low ν

Absorption of energy and excitation



Emission and de-excitation



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