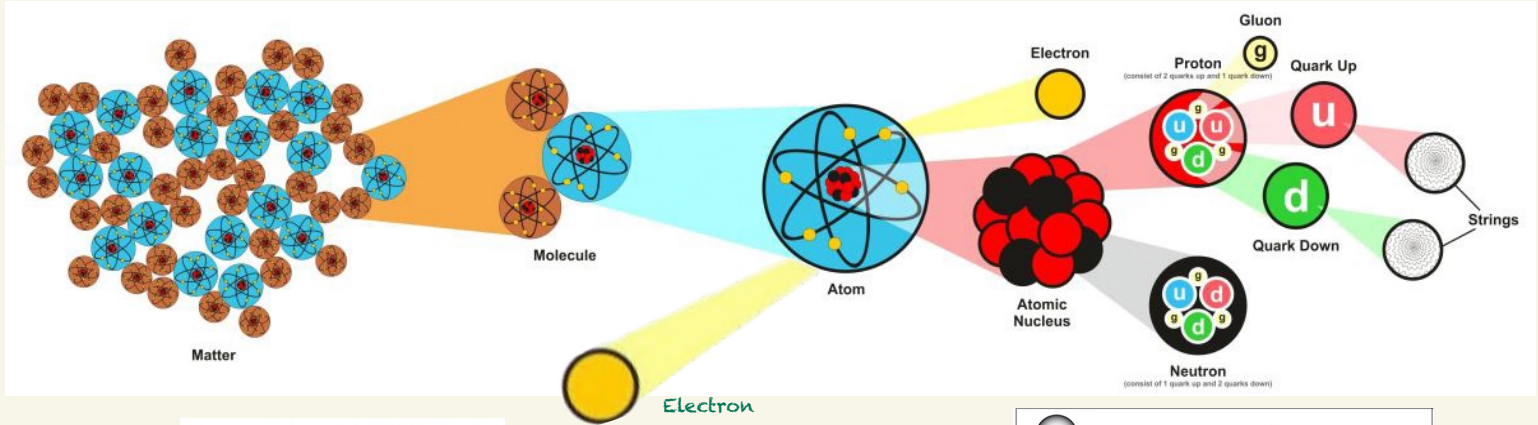




Structure of atom

	Proton	1.67×10^{-27}	$+1.602 \times 10^{-19}$
--	--------	------------------------	--------------------------



	Neutron	1.67×10^{-27}	0
--	---------	------------------------	---

	Electron	9.11×10^{-31}	-1.602×10^{-19}
--	----------	------------------------	--------------------------

Wave function Ψ
 Ψ^2

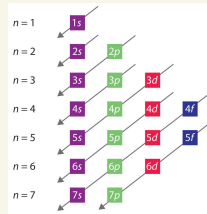
distribution of electron density

$$\Psi(r, \theta, \phi) = R(r)P(\theta)F(\phi)$$

n ← principal quantum number
 ℓ ← orbital quantum number
 m_ℓ ← magnetic quantum number

Solution of this equation

n = principal	l = angular	m = magnetic	S = spin
distance from nucleus	shape of orbital	orientation in space	electron spin



average relative distance of an electron from the nucleus

n

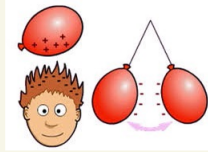
shape of the region of space occupied by an electron

l

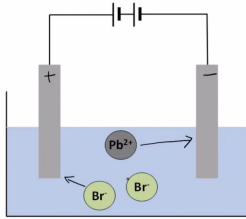
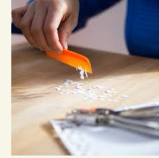
orientation of the region of space occupied by an electron with respect to an applied magnetic field

m

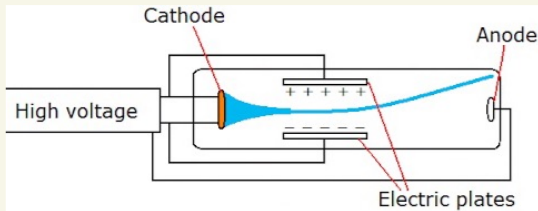
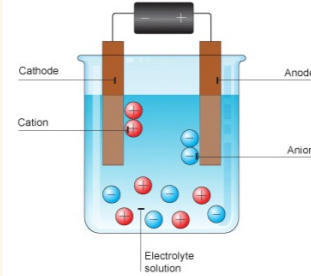
Verification of electrical nature of matter



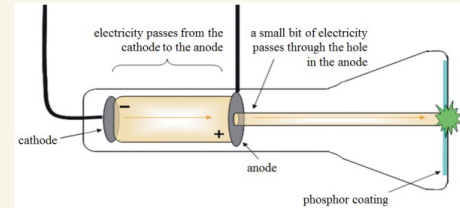
Frictional
electricity



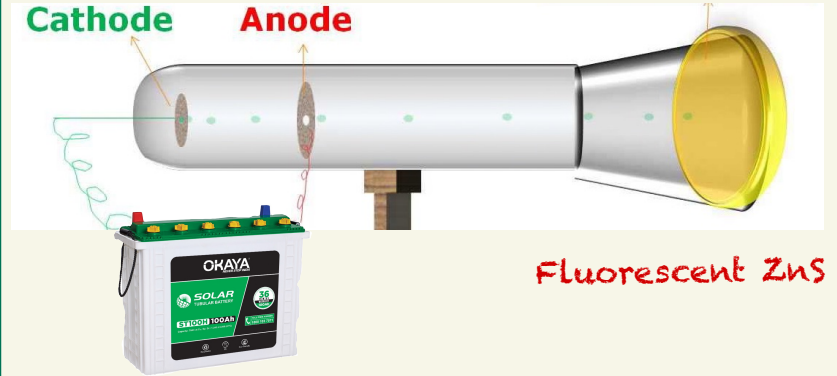
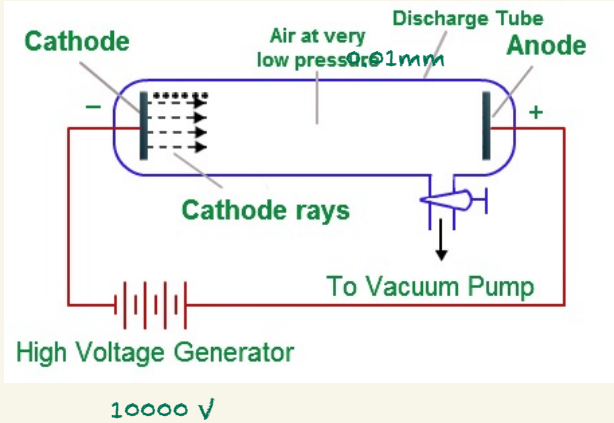
Electrolysis



Cathode ray
experiment



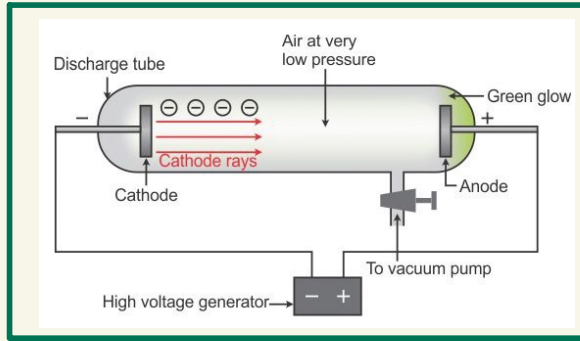
Cathode ray discharge tube experiment : discovery of electron



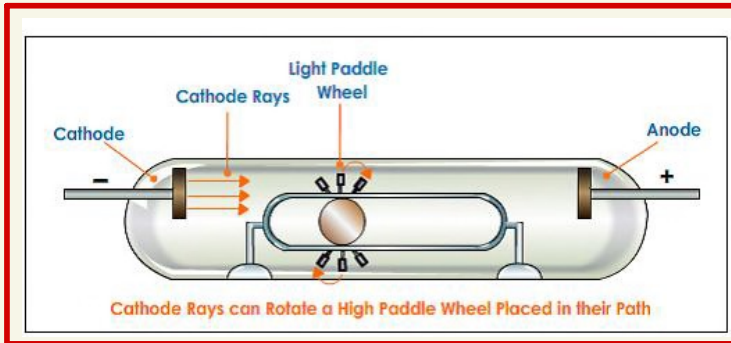
Observations



These rays are not visible but their behaviour can be observed with the help of fluorescent or phosphorescent

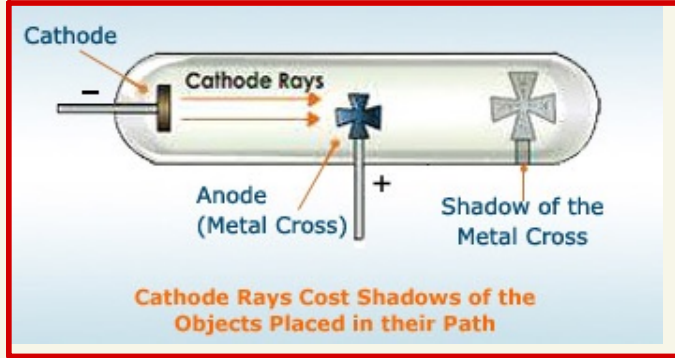


They produce heating effects which make wheel paddle to rotate (radiometric effects)

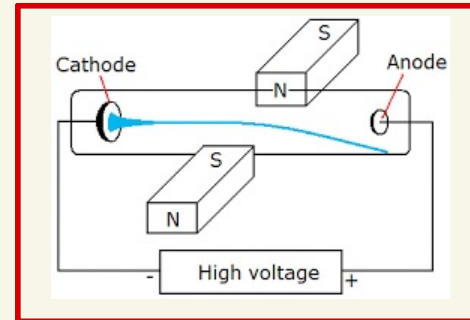
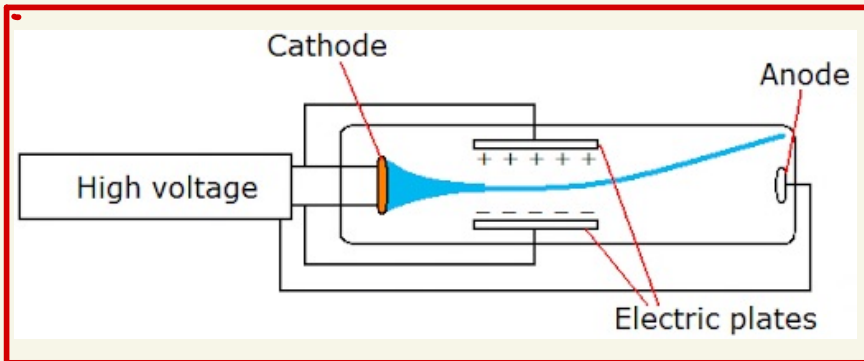




They produce sharp shadow of object placed in their path showing they travel in straight lines in the absence of electrical or magnetic field

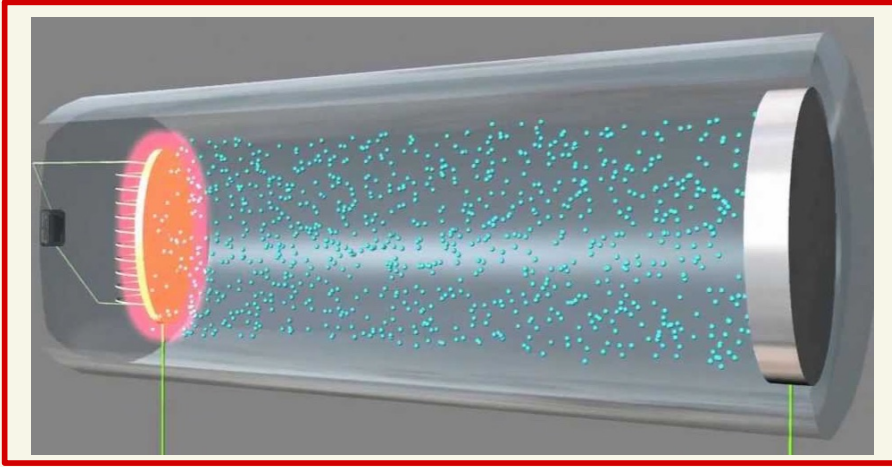


In the presence of electrical or magnetic field they behave like a negatively charged particles, suggesting cathode rays are negatively charged particle (electrons)

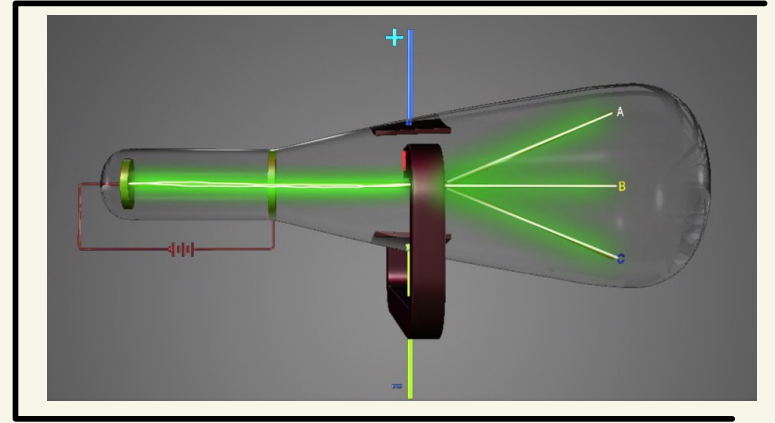
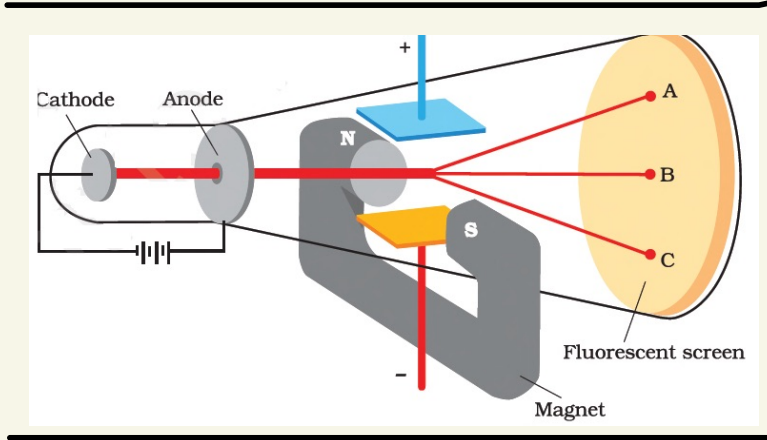




The characteristics of cathode rays do not depend upon the material of electrodes and the nature of gas present in the cathode ray tube



Charge to mass ratio of electrons



💡 When only electric field is applied the electron hits at point A

💡 When only magnetic field is applied electron strikes at Point C

💡 When electric field and magnetic field was balanced the electrons followed straight line and hit at point B

The deviation of the particles depends upon

$$y = \frac{1}{2}at^2 = \frac{1}{2} \frac{eV}{m} t^2$$

$$\frac{q}{m} = \frac{v_0^2 \tan \theta}{El} = \frac{E \tan \theta}{B^2 l}$$



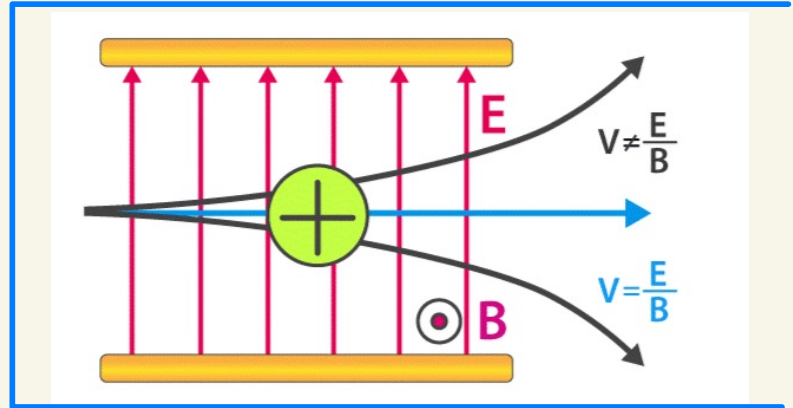
The magnitude of negative charge on the particle greater the magnitude greater the deflection



The mass of the particle lie to the particle greater the



The strength of electrical or magnetic field



$$\frac{e}{m_e} = 1.758820 \times 10^{11} \text{ C kg}^{-1}$$

Charge on the electron

First, fine oil drops were sprayed from an atomizer into the air. An atomizer operates much like modern spray bottle. These drops were charged by friction with the atomizer as they were sprayed. Gravity acting on the drops caused them to fall, and a few of them entered the hole in the top plate of the apparatus.

An electric potential difference then was placed across the two plates. The resulting electric field between the plates exerted a force on the charged drops. When the top plate was made positive enough, the electric force caused negatively charged drops to rise. The electric potential difference between the plates was adjusted to suspend a charged drop between the plates. At this point, the downward force of Earth's gravity and the upward force of the electric field were equal in magnitude. The magnitude of the electric field, E , was determined from the electric potential difference between the plates.

A second measurement had to be made to find the weight of the drop using the relationship mg , which was too tiny to measure by ordinary methods. To make this measurement, a drop first was suspended. Then, the electric field was turned off, and the rate of the fall of the drop was measured. Because of friction with the air molecules, the oil drop quickly reached terminal velocity, which was related to the mass of the drop by a complex equation. Using the measured terminal velocity to calculate mg and knowing E , the charge, q , could be calculated.

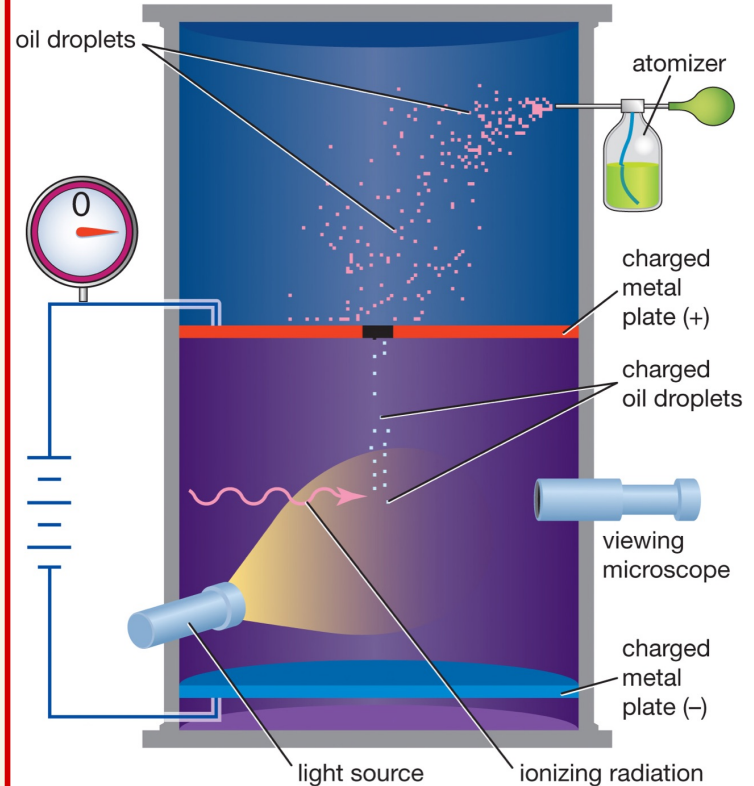
Millikan concluded that the magnitude of electrical charge, q , on the droplets is always an integral multiple of the electrical charge, e , that is, $q = n e$, where $n = 1, 2, 3, \dots$

$- 1.6022 \times 10^{-19} \text{ C}$. The

$$m_e = \frac{e}{e/m_e} =$$

$$= 9.1094 \times 10^{-31} \text{ kg}$$

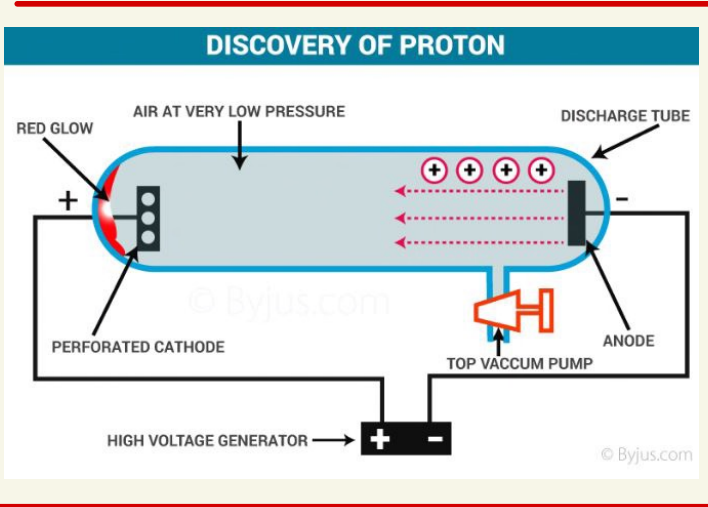
Millikan's oil drop experiment



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Discovery of protons : anode (canal) rays

Characteristics



Its properties depends upon the nature of gas present in the cathode ray tube they are simply the positively charged gaseous ions.



Charge to Mass ratio of the particle is found to depend on the gas from which these originate

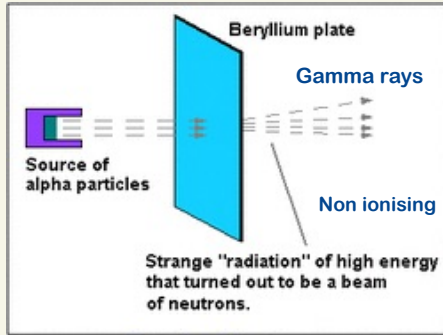


Some of the positively charged particles carry a multiple of the fundamental unit of electrical charge



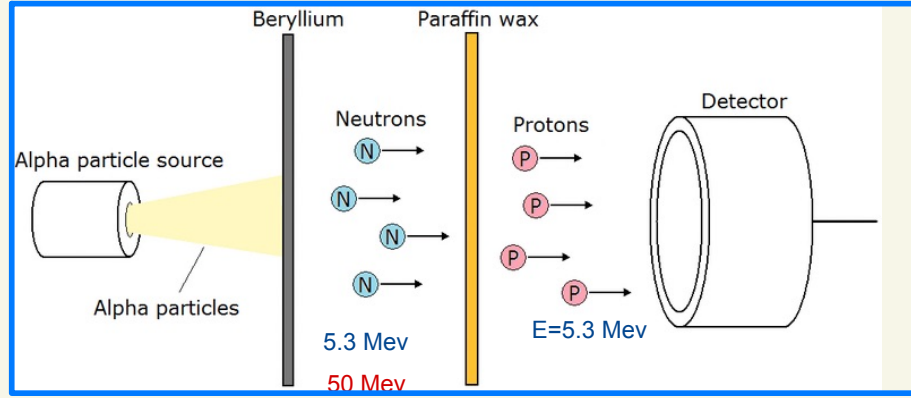
The behaviour of this particle in the magnetic or electrical field is opposite to that observed for electrons or cathode rays

Discovery of neutron by Chadwick



Detection of neutrons

Bothe and Becker



Curie and Joliot

Case 1

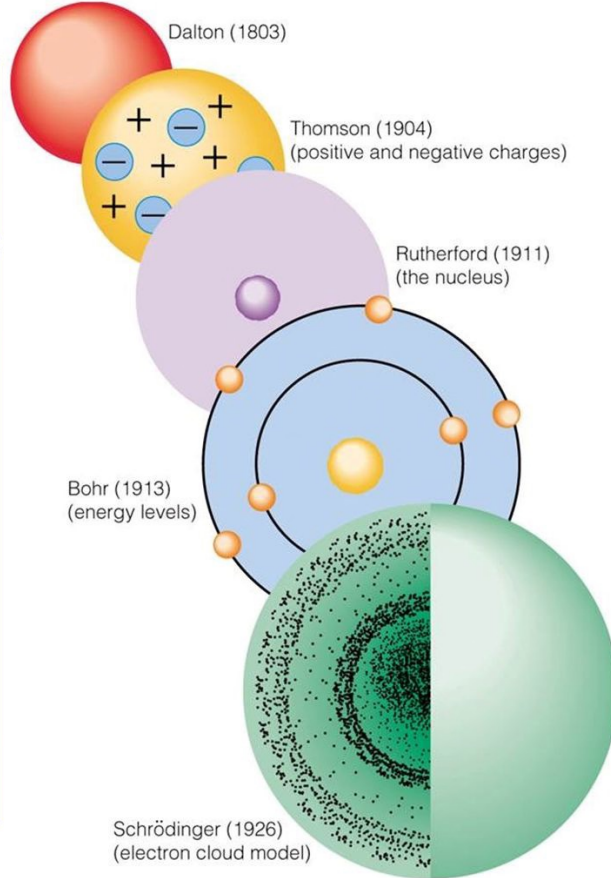
If neutral radiation is photon then $E=50 \text{ Mev}$
This much of energy is not possible within nucleus, so neutral radiation must be neutral particle

Case 2

For head on collision

Energy of neutron must be within the range of energy in nucleus 5.3 Mev , so this neutral particle must have mass comparable to proton

Evolution of the Atom



Atomic
model

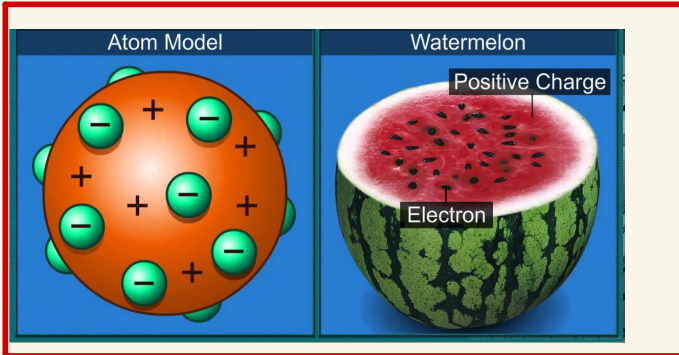
Thomson model



Thomson believed that the electrons were like plums embedded in a positively charged "pudding," thus it was called the "plum pudding" model.



Mass of the atom is assumed to be uniformly distributed over the atom



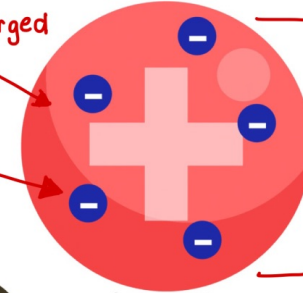
Plum-Pudding Model



1904

positively charged sphere

fixed e^-



whole atom is neutral

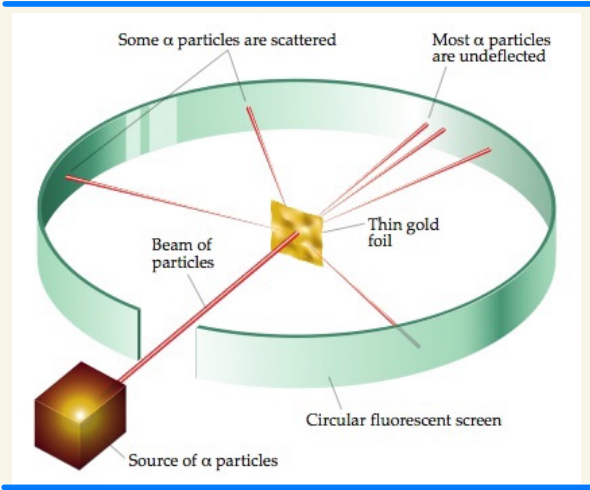


He found that :

- An atom consists of $\left\{ \begin{array}{l} \text{positive charge} \\ \text{negative charge} \end{array} \right.$
- An atom is electrically neutral
 - ↳ positive = negative
- Negatively charged electrons are fixed in the positive sphere

Joseph John Thomson

Rutherford nuclear model



Observation



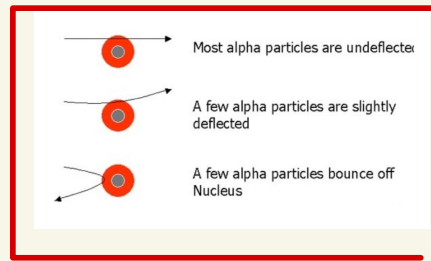
Most of the alpha particles passed through the gold foil undeflected



A small fraction of alpha particles was deflected by small angles



Very few alpha particles 1 in 20,000 bounced back by 180°



Conclusion



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

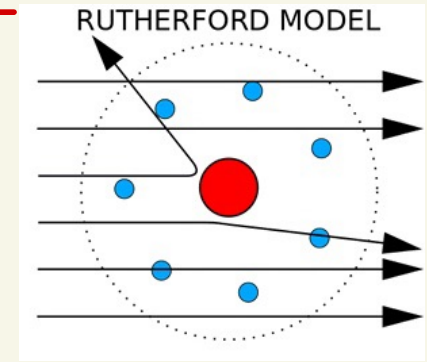


Very few particles were deflected from their path, indicating that the positive charge of the atom occupies very little space.

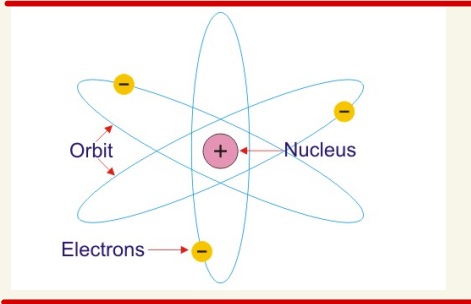


A very small fraction of α -particles were deflected by very large angles, indicating that all the positive charge and mass of the gold atom were concentrated in a very small volume within the atom

The radius of atom is about 10^{-10} while that of nucleus is 10^{-15} m



Rutherford nuclear model.



There is a positively charged centre in an atom called the nucleus. Nearly all the mass of an atom resides in the nucleus.

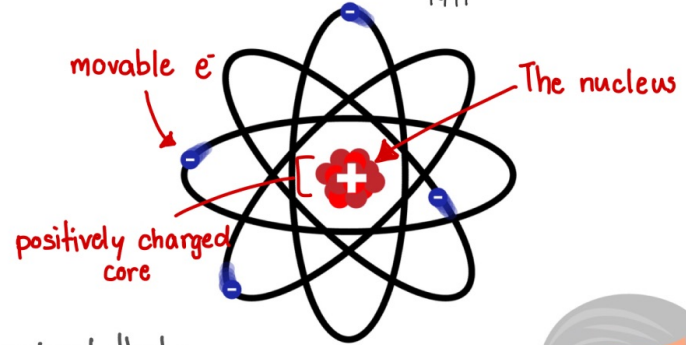


The electrons revolve around the nucleus with a very high speed in a circular path called orbits like planets revolve around the sun



Electrons are you place are held together by electrostatic force of attraction

Nuclear Model



He theorized that:

- Atoms are mainly empty space
- Positive charge is concentrated at the center of atom, the nucleus
- The center of atom = the nucleus
- Electrons move around the nucleus

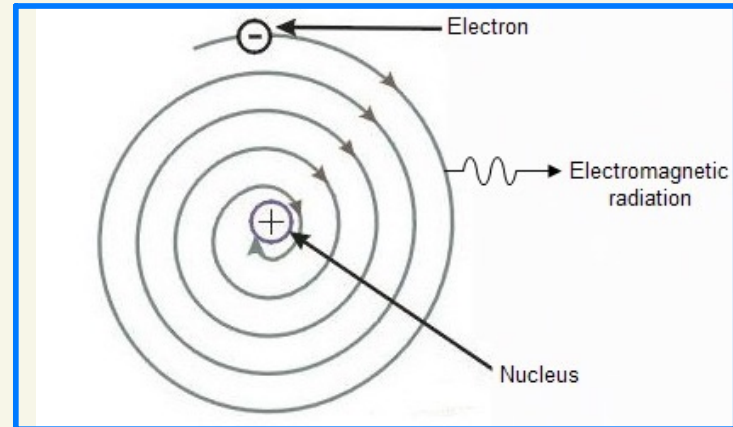
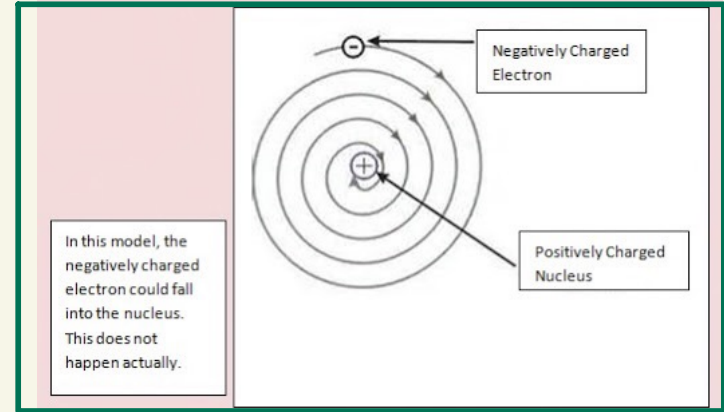


Drawbacks of Rutherford model

- According to electromagnetic theory a charged particle when accelerated emits energy in the form of electromagnetic radiation. According to Rutherford's model, electrons are revolving around the nucleus. This means, electrons would be in a state of acceleration all the time. Since electrons are charged particles so electrons should emit radiation and as a result they get slow down and finally fall into the nucleus by following a spiral path. Rutherford's model failed to explain stability of atoms.

- **Rutherford's** atomic model could not explain how the moving electrons could remain in its orbit.

- It doesn't say anything about the electronic structure of atom that is how the electrons are distributed around the nucleus and what are the energies of these electrons



Atomic number and mass number

Mass number

Number of protons and neutrons in atom

Neutron number

Number of neutrons in atom

$$N = A - Z$$



Atomic symbol

Abbreviation used to represent atom in chemical formulas

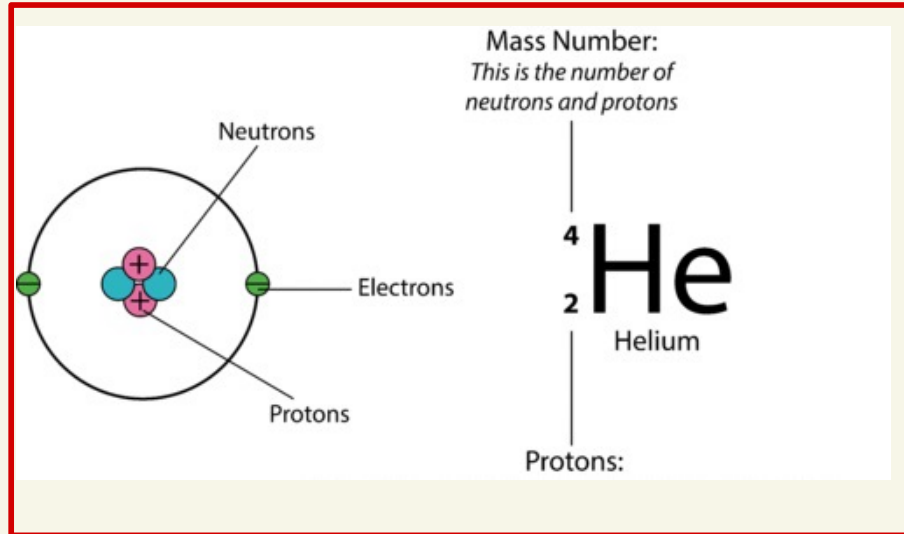
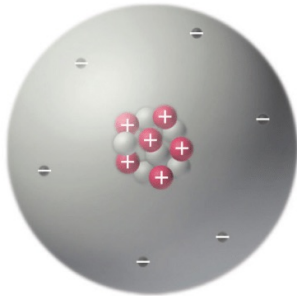
Atomic number

Number of protons in atom

Or no of e in neutral atom

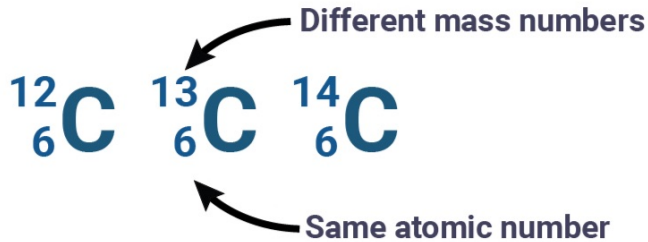


6 protons +
6 neutrons ●
6 electrons ●



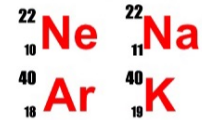
Isotopes, isobars, isotones, isodiaphers

Isotopes



Isobar

- Same mass numbers
- Different atomic number



Isotones

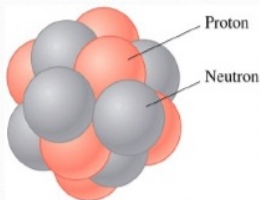
Atoms having the same number of neutrons are called isotones

X

A=131

N= 53

Z= 78



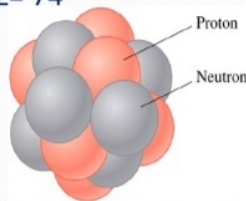
Y

A= 127

N= 53

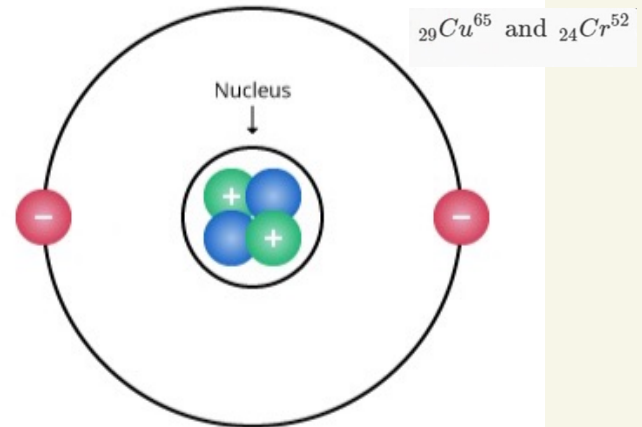
Z= 74

Same



isodiaphers

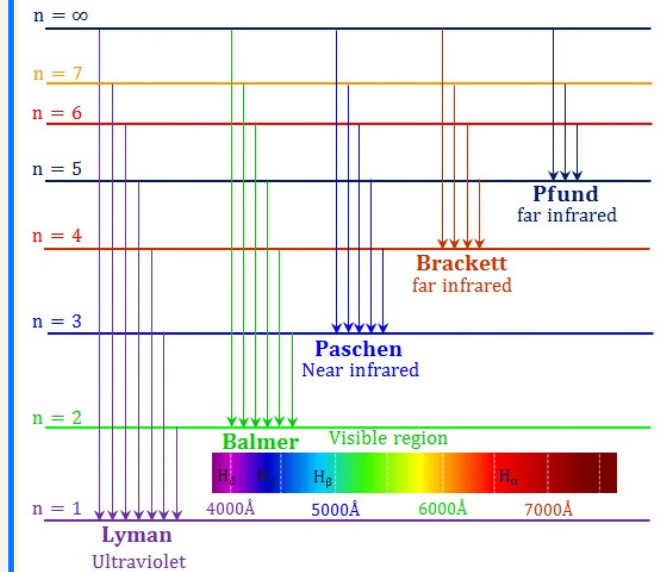
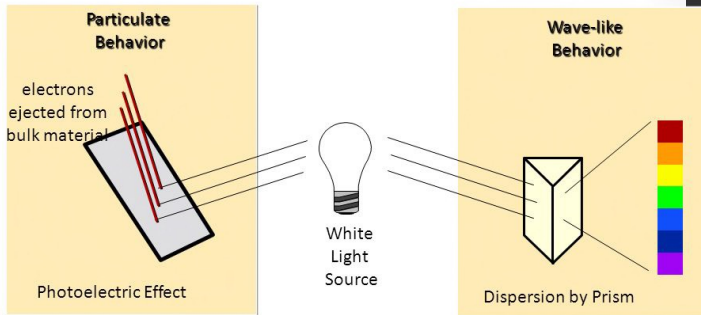
Same n-p



Developments leading to the Bohr model of atom

The Dual Nature of Light

- Light has both wave-like and particle-like nature



Wave nature of E.M.W

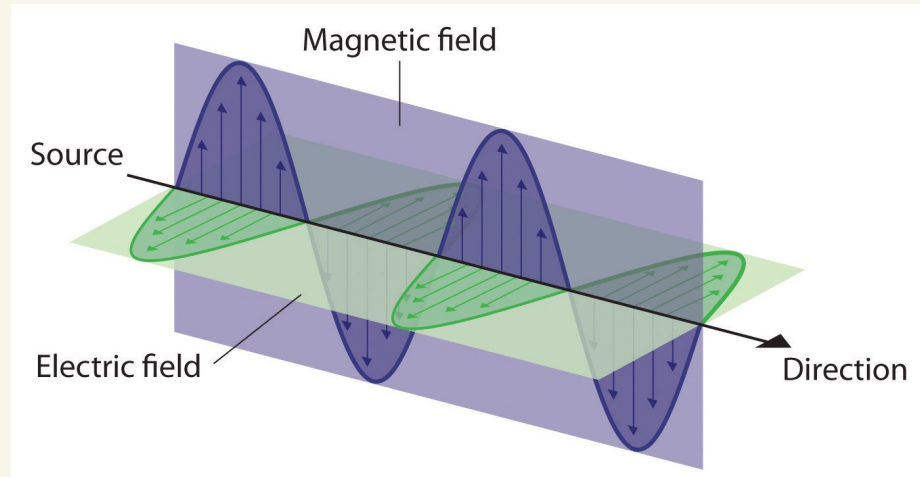
James Maxwell



When electrically charged particle moves under acceleration alternating electrical and magnetic fields are produced and transmitted in the forms of waves call electromagnetic waves or radiation



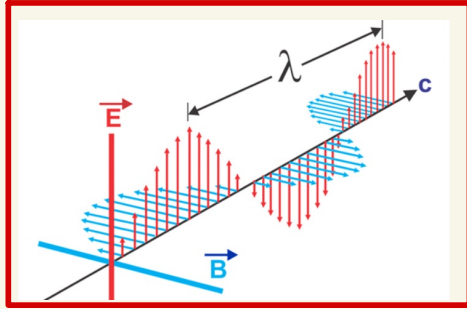
He revealed that light waves are associated with oscillating electric and magnetic character



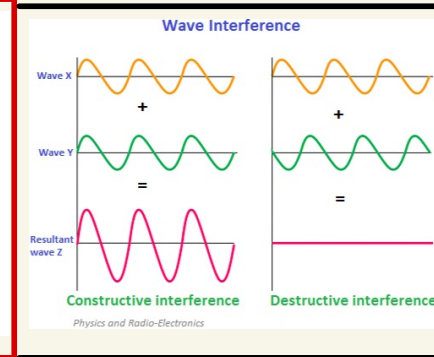
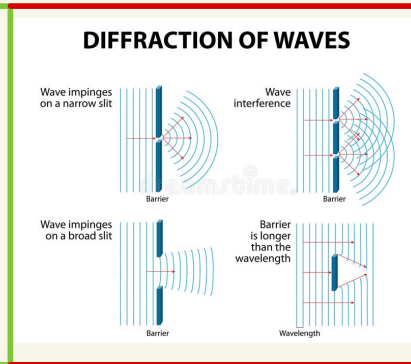
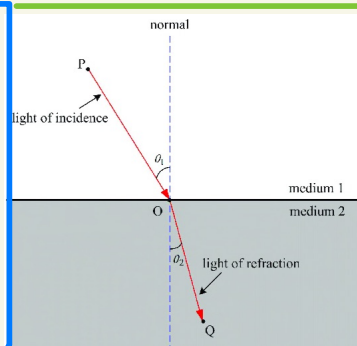
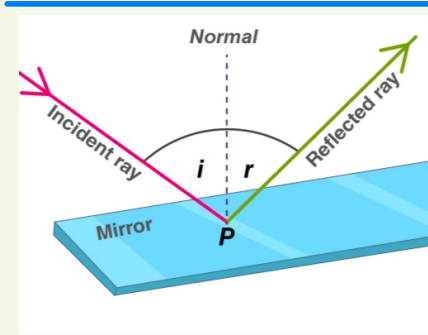
Properties of E.M.W



The oscillating electric and magnetic field produced by oscillating charged particles are perpendicular to each other and both are perpendicular to the direction of propagation of the wave



It shows different phenomena like reflection, refraction, diffraction and interference

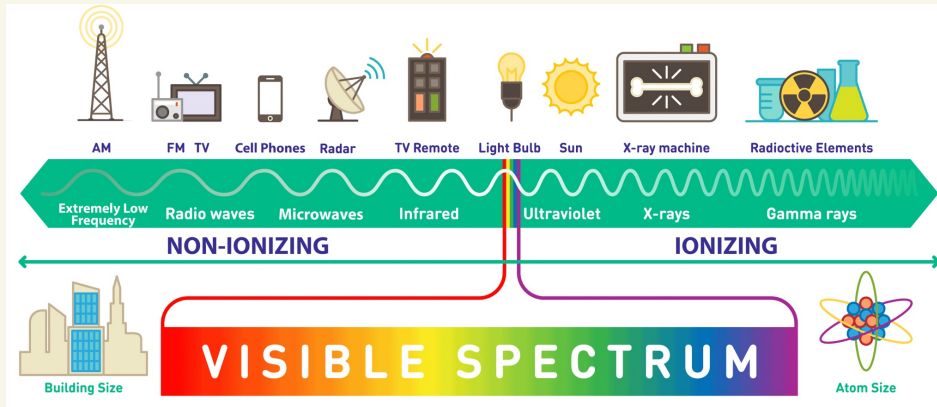




Unlike sound waves or water waves electromagnetic waves do not require medium and can move in vacuum



It consists of different types of electromagnetic radiation which differ from one another in wavelength or frequency. these are called electromagnetic spectrum

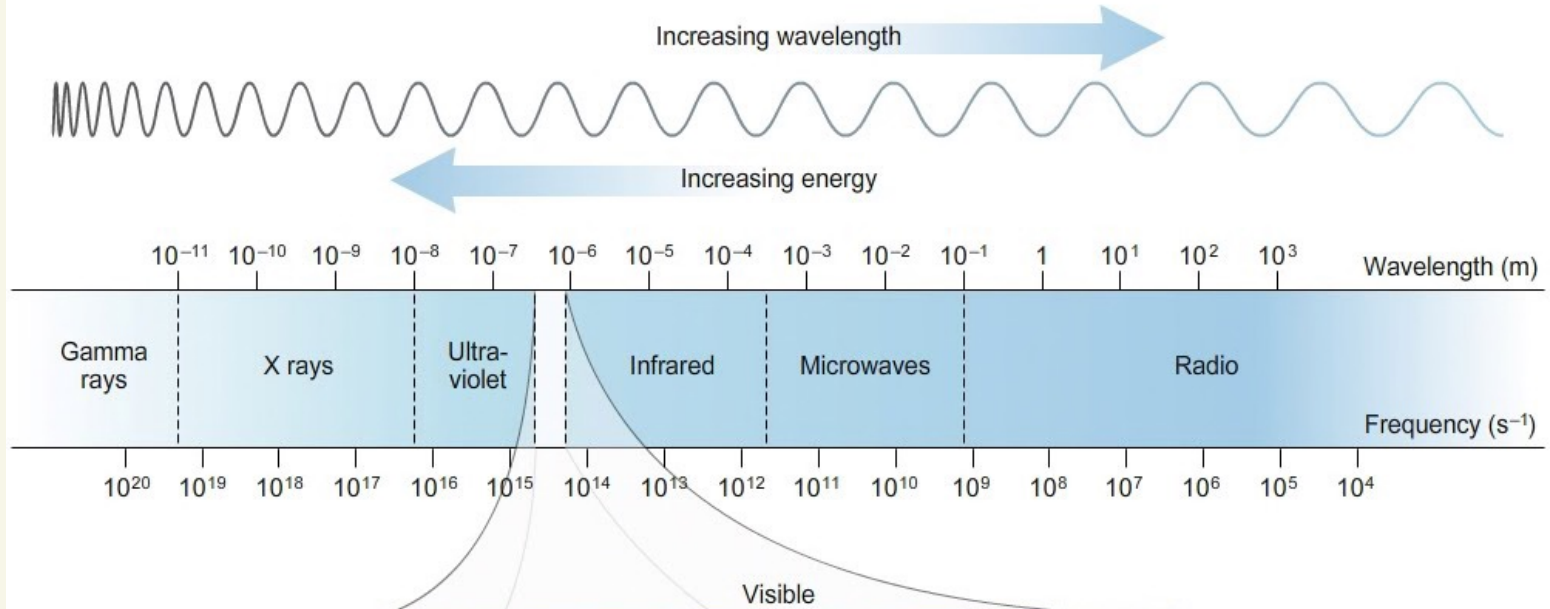


It travels with the speed of light

$$c = 3 \times 10^8 \text{ m/s (in the vacuum)}$$

$$v = c/n \text{ (in the media)}$$

Electromagnetic spectrum



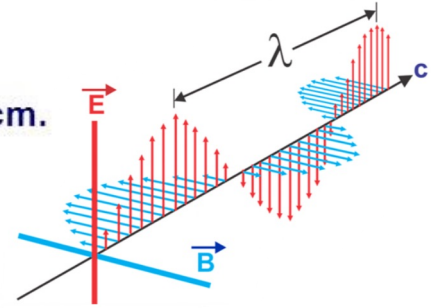
Electromagnetic Waves - Terminologies

Electromagnetic wave parameters:

Wave number ($\bar{\nu}$): Wave number is the number of waves per cm.

Frequency (ν): Number of waves that pass a given point in one second

Wavelength, Wave number and Frequency are interrelated as,



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

Where,

λ is wave length

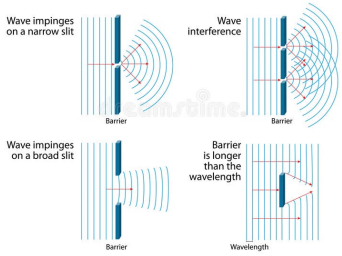
$\bar{\nu}$ is wave number

ν is frequency

c is velocity of light in vacuum. i.e., 3×10^8 m/s

Wave phenomena

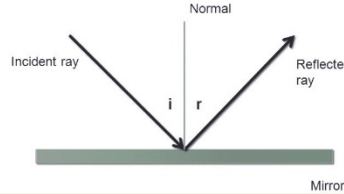
DIFFRACTION OF WAVES



Reflection of light

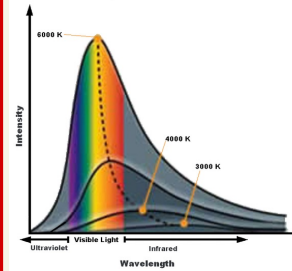
The law of reflection states that:
the angle of incidence = the angle of reflection

$$i = r$$



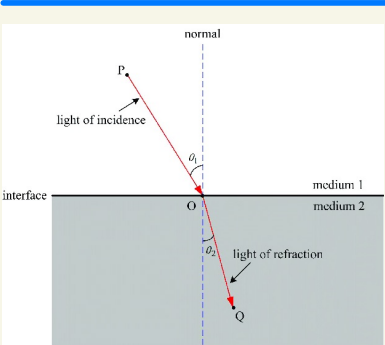
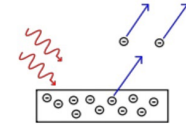
Particle phenomena

Blackbody Radiation Curves

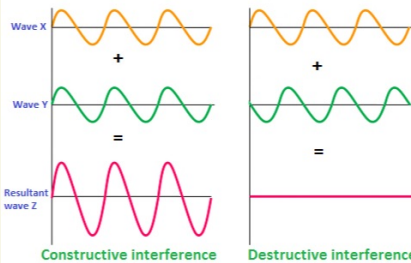


Photoelectric Effect

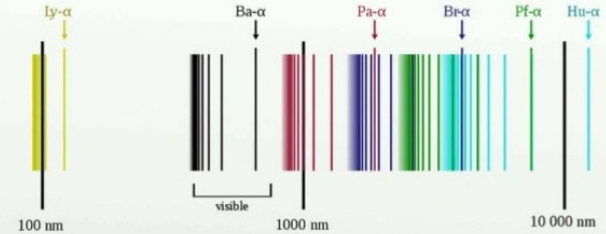
The photoelectric effect refers to the **emission, or ejection, of electrons from the surface of, generally, a metal** in response to incident light.



Wave Interference



Hydrogen spectral series



Blackbody radiation by Max Planck