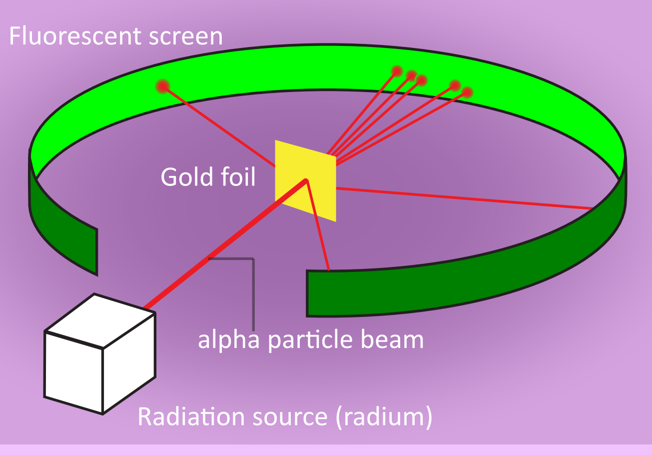
ATOMS

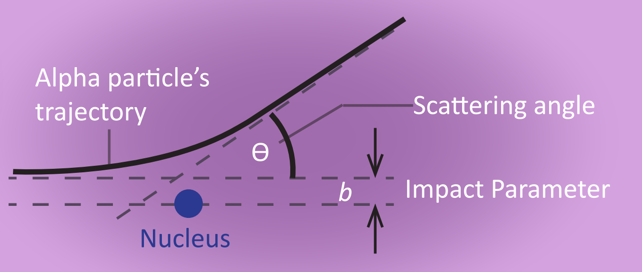
Rutherford's Atomic Model

- In 1911, Giger and Marsden carried out a series of experiment called α-particle scattering experiment.
- A beam of α-particle is directed towards 10^{-8}m thick gold foil. Source of a -partides is radium. The gold foil is surrounded by a circular line sulphide coated screen. A flash of light is produced as an α-particle strikes the screen.

Ernest Rutherford

- Rutherford gave an estimate of size of nucleus and atom by calculating impact parameter and distance of closest approach.
- **Distance of closest approach**(*d*) It is distance between an α-particle and nucleus from where α-particle is repelled back on its path in a head on collision.
- **Impact parameter** *(b)* It is the perpendicular distance of line of velocity vector of α-particle and centre line of nucleus.





Drawback of the Model

- The orbital revolution of electron around the positively charged nucleus is not expected to be stable.
- It could not explain atomic spectra of H-atom and discontinuous spectrum.

Bohr's Atomic Model

Niels Bohr

Postulates

- Electrons revolve around the nucleus in specific circular orbits having angular momentum as the integral multiple of $\frac{h}{2\pi}$, i.e. $mvr = \frac{nh}{2\pi}$. Each orbit can contain only a set of number of electrons.
- As long as electron remains in a particular orbit, it neither emits nor gains energy.
- Each stationary orbit is associated with a definite amount of energy. The greater is the distance of the orbit from the nucleus, more will be the energy associated with it.
- An electron can jump from one energy level to another by emitting quanta of energies called photons.

Radius of Orbit :

$$r_n = \frac{n^2h^2\varepsilon_0}{\pi mZe^2} = \frac{0.53n^2}{Z}(\text{Å})$$

$$\boxed{r^2_n \propto \frac{n^2}{Z}}$$

Velocity of Electron :

$$v_n = \frac{Ze^2}{2\varepsilon_0 nh} = \frac{c}{137}.\frac{Z}{n}$$

$$\boxed{v_n \propto \frac{Z}{n}}$$

Energy of Electron :

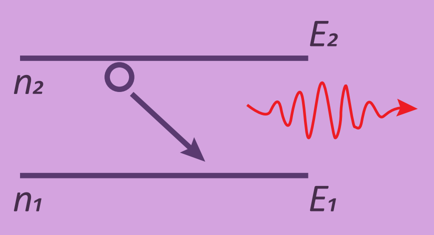
$$E_n = \left(\frac{me^4}{8\varepsilon^2_0 ch^3}\right)ch.\frac{Z^2}{n^2}$$

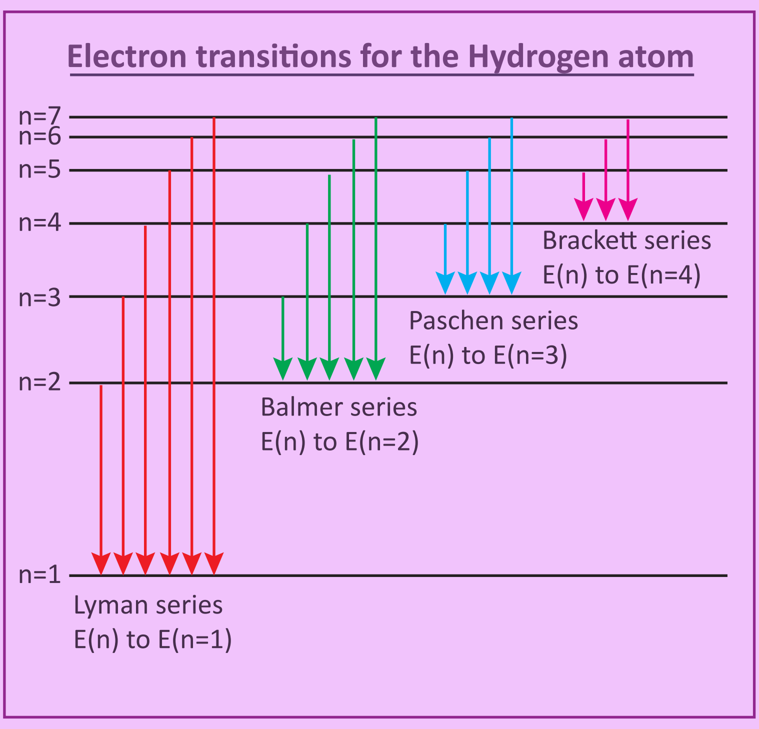
$$\boxed{= -13.6\frac{Z^2}{n^2}(eV)}$$

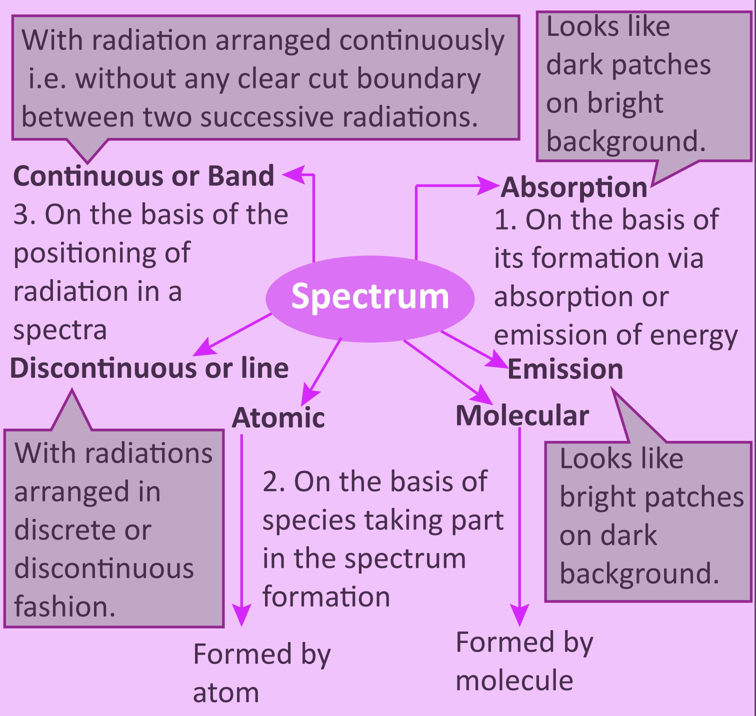
Atomic Spectra :

$$v = \frac{1}{\lambda} R_H Z^2 \left[\frac{1}{n^2_0} - \frac{1}{n^2_2}\right], n_1 < n_2$$

$$R_H = \frac{2\pi^2 m_e e^4}{ch^3} = \text{Rydberg's Constant}$$







Series of lines	n_1	n_2	Spectral region	Wavelength range
Lymen series	1	2,3,...∞	UV light < 4000 Å	$1/R_H$ - $4/3R_H$
Balmer series	2	3,4,...∞	Visible 4000-7000 Å	$4/R_H$ - $36/5R_H$
Paschen series	3	4,5,...∞	Near IR > 7000 Å	$9/R_H$ - $144/7R_H$
Brackett series	4	5,6,...∞	IR > 7000 Å	$16/R_H$ - $400/9R_H$
Pfund series	5	6,7,...∞	Far IR > 7000 Å	$25/R_H$ - $900/11R_H$
Humphrey series	6	7,8,...∞	Far IR > 7000 Å	$36/R_H$ - $1764/13R_H$

Drawback of the Bohr's Model

(i) It is unable to explain hydrogen atom spectrum (doublet, triplet etc.) observed by using spectroscopic techniques.
(ii) It is unable to explain the spectrum of atoms/ions having more than one electron.
(iii) It is unable to explain the ability of atom to form molecules by chemical bonds.