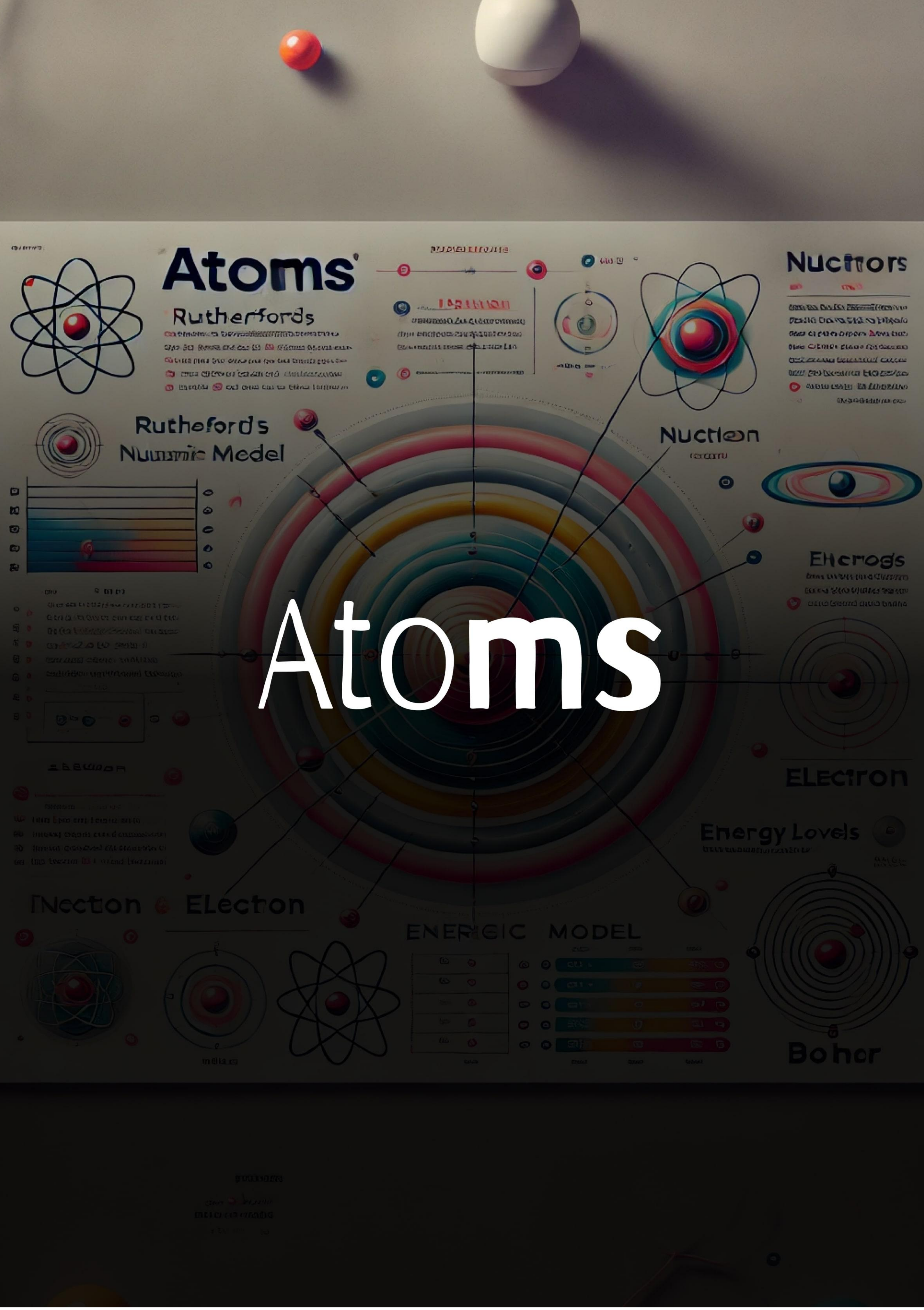
Atoms



ATOM

THOMSON'S ATOMIC MODEL

The atom as a whole is electrically neutral because the positive charge present on the atom (sphere) is equal to the negative of electrons present in the sphere.

Atom is positively charged sphere of radius 10^{-10} m in which electrons are embedded in between.

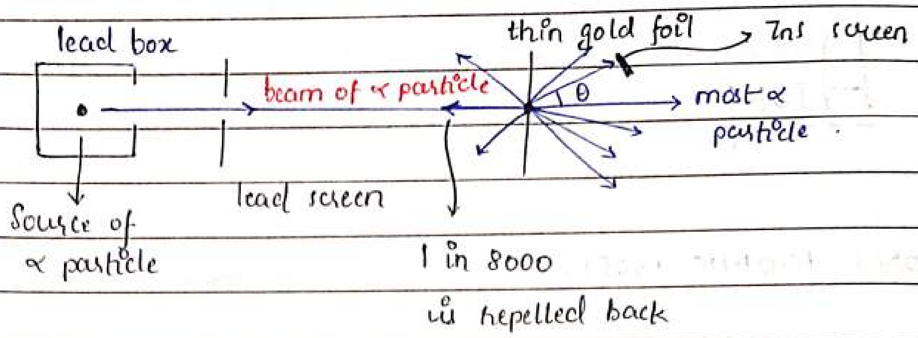
The positive charge and the whole mass of the atom is uniformly distributed throughout the sphere.

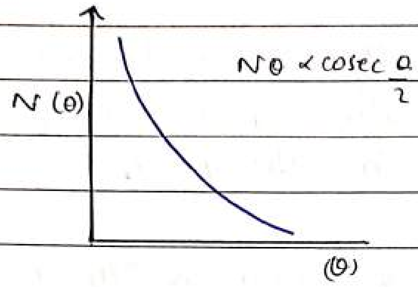
Shortcomings of Thomson's model

⇒ The spectrum of atoms cannot be explained with the help of this model.

⇒ Scattering of α particles cannot be explained with the help of this model.

Rutherford Atomic model





$$N(\theta) = \frac{k Z^2 e^4}{(KE_\alpha)^2 \sin^4(\theta/2)} \propto \operatorname{cosec}^4(\theta/2)$$

Most of the α particle went straight through the gold foil and produced flash on the screen as if there is nothing inside gold foil. Thus the atom is hollow.

Few particles collided with the atoms of the foil which have scattered or deflected through considerable large angles. Few particles even turned back towards source itself.

The entire positive charge and almost whole mass of the atom is concentrated in small centre called a nucleus.

The electrons could not deflected the path of α particle i.e. electrons are very light.

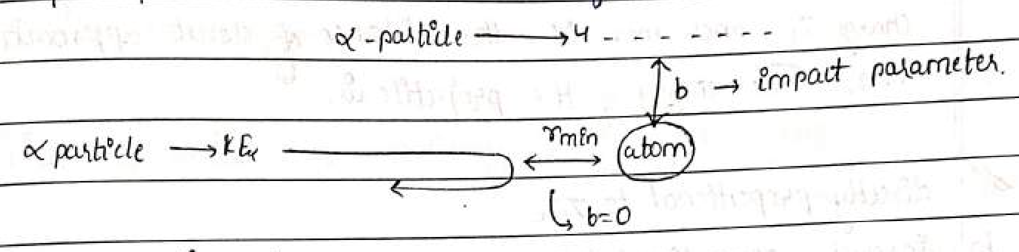
Nucleus at the centre (diameter < 10^{-13} m)
↓
surrounded by electron clouds.

$r_{atom} = 10^{-10} m = 1 \text{Å}$

$r_{nucleus} = 10^{-15} m = 1 fm$

$\frac{r_{atom}}{r_{nucleus}} = \frac{10^{-10}}{10^{-15}} = 10^5$

Impact parameter (minimum distance of approach)



Now (COM.E)

$(KE+U)_i = (KE+U)_f$

$KE_\alpha + 0 = 0 + \frac{2KZe^2}{r_{min}}$

$$\boxed{r_{min} = \frac{2KZe^2}{KE_\alpha} = \frac{2KZe^2}{\frac{1}{2}m_\alpha v^2} = \frac{4KZe^2}{m_\alpha v^2}}$$

Q When an α particle of mass 'm' moving with velocity 'v' bombards on a heavy nucleus of charge 'Ze' its distance of closest approach from the nucleus depends on.

(a) $1/m$ (b) $1/\sqrt{m}$

c) $1/m^2$ d) m

Q In Rutherford scattering experiment, what will be the correct angle for α- scattering for an impact parameter $b = 0$?

a) 90° b) 270°
c) 0° d) 180°

Q In Rutherford scattering experiment when a projectile of charge Z_1 and mass M_1 approaches a target nucleus of charge Z_2 and mass M_2, the distance of closest approach is r_0. The energy of the projectile is.

a) directly proportional to $Z_1 Z_2$
b) inversely proportional to Z_1
c) directly proportional to mass M_1
d) directly proportional to $M_1 \times M_2$

ANS

DRAWBACK OF RUTHERFORD MODEL

⇒ This model did not explain line spectrum of atom
⇒ Unable to explain stability of atom
⇒ electron is a charge so when it is accelerated around nucleus then e^- must be emitting Em wave hence it lose energy and it will collapse in nucleus.

Bohr's first postulate

Bohr's first postulate was that an electron in an atom could revolve in certain stable orbits without the emission of radiant energy contrary to the predictions of electromagnetic theory

According to this postulate, each atom has certain definite stable states in which it can exist, and each possible state has definite total energy.

These are called the stationary states of the atom.

Bohr's second postulate

Bohr's second postulate defines these stable orbits. This postulate states that the electron revolves around the nucleus only in those orbits for which the angular momentum is some integral multiple of $h/2\pi$ where h is the planck's constant

$(h = 6.6 \times 10^{-34}\ Js)$

Thus the angular momentum (L) of the orbiting electron is quantised. That is $L = nh/2\pi$.

$$L = n\left(\frac{h}{2\pi}\right)$$

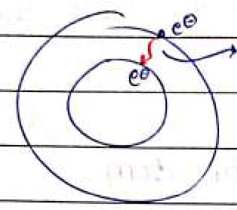
$$n = 1, 2, 3 \ldots$$

Boahr's third postulate.

Bohr's third postulate incorporate into atomic theory the early quantum concepts that had been developed by planck and Einstein

It states that an electron might make a transition from one of its specified non radiating orbits to another of lower energy.

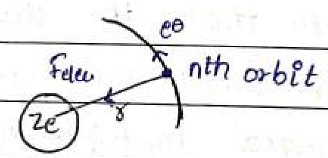
When it does so, a photon is emitted having energy equal to the energy difference between the initial and final states.



Velocity of e⊖ in n^{th} Orbit.

$$F_{centrepetal} = \frac{mv^2}{\cancel{r}} = \frac{KZe \times e}{r^{\cancel{2}}}$$

$$\boxed{mv^2 = \frac{Ze^2}{4\pi\epsilon_0 r}} \quad -① \qquad L = \frac{nh}{2\pi}$$



$$L = mvr$$

$$\boxed{mvr = \frac{nh}{2\pi}} \quad -②$$

$$v(mvr) = \frac{Ze^2}{4\pi\epsilon_0}$$

$$v\frac{nh}{\cancel{2\pi}} = \frac{Ze^2}{_2\cancel{4\pi}\epsilon_0}$$

$$\boxed{v = \frac{e^2}{2\epsilon_0 h}\left(\frac{Z}{n}\right)}$$

$$\boxed{V = \frac{V_0 Z}{n}} \qquad V_0 = 2.2 \times 10^6 \ m/s$$

$$\downarrow$$

$$V \propto Z \propto \frac{1}{n} \qquad \frac{c}{137}\frac{Z}{n}$$

RADIUS OF N^{th} ORBIT

$$mv^2 = \frac{Ze^2}{4\pi\epsilon_0 r} \quad -(1)$$

$$mvr = \frac{nh}{2\pi} \quad -(2)$$

$$\frac{1}{(2)^2} \Rightarrow \frac{mv^2}{m^2v^2r^2} = \frac{Z^2e^4}{}$$

$$r = \frac{nh}{2\pi mv} \qquad \left[v = \frac{e^2 hZ}{2\epsilon_0 hn}\right]$$

$$r = \frac{nh \, \cancel{2}\epsilon_0 hn}{\cancel{2}\pi m e^2 Z}$$

$$r = \frac{\epsilon_0 h^2 n^2}{me^2 Z}$$

$$r = r_0\left(\frac{n^2}{Z}\right) \Rightarrow \boxed{r = \frac{r_0 n^2}{Z}} \qquad r_0 = \frac{\epsilon_0 h^2}{\pi me^2} = 0.53 \mathring{A}$$

$$r \propto n^2$$

$$r \propto \frac{1}{Z}$$

1^{st} orbit of hydrogen atom

$n=1, Z=1$

$r = 0.53 \mathring{A}$

$v = 2.2 \times 10^6 \ m/s$

2nd orbit

$n=2$

$Z=1$

$r = 4 \times 0.53 \mathring{A}$

$v = 1.1 \times 10^6 \ m/s$

3rd orbit

$n=3,\ Z=1$

$r = 9 \times 0.53\ \mathring{A}$

$v = \frac{2.2 \times 10^6 m/s}{3}$

3.4. Time period of revolution of election in n^{th} orbit

$T = \frac{2\pi r}{v}$ (of n^{th} orbit)

$= \frac{2\pi r_0 n^2}{v_0 \frac{Z}{n} Z}$ $\qquad f = \frac{1}{T}$

$\Rightarrow \frac{2\pi r_0 n^3}{v_0 Z^2}$

$T = \frac{2\pi r_0 n^3}{v_0 Z^2}$

$\boxed{T = T_0 \frac{n^3}{Z^2}}$ $\qquad T_0 = 1.51 \times 10^{-16}$..

$\boxed{f = \frac{1}{T} = \frac{2}{3} \times 10^{16} \frac{Z^2}{n^3}}$

4.) Current and magnetic field

$e^{\ominus}$ n^{th} orbit r

$B = \frac{\mu_0 I}{2R} = \frac{\mu_0 e}{2R\,t} = \frac{\mu_0 e}{2 \frac{r_0 n^2}{Z} \times T_0 \frac{n^3}{Z^2}}$

$\boxed{B \propto \frac{Z^3}{n^5}}$

If for $n=1$ $B = B_0$

then for $n=2$ $B = ?$ $\qquad B = \frac{B_0}{32}$

5) Total energy of electron in nth orbit

$KE = \frac{1}{2} m v^2$ $\qquad mv^2 = \frac{Ze^2}{4\pi\epsilon_0 r}$ $\qquad KE = \frac{me^4}{8n^2h^2\epsilon_0^2}$ $\qquad K \propto \frac{1}{n^2}$

$\Rightarrow \frac{1}{2} \frac{Ze^2}{4\pi\epsilon_0 r}$

$E_{total} = KE + U$ $\qquad PE \propto \frac{1}{n^2}$

$\boxed{KE = \frac{Ze^2}{8\pi\epsilon_0 r}}$ $\qquad TE = \frac{Ze^2}{8\pi\epsilon_0 r} - \frac{Ze^2}{4\pi\epsilon_0 r}$

$\boxed{U = \frac{-Ze^2}{4\pi\epsilon_0 r}}$ $\qquad TE = \frac{Ze^2}{4\pi\epsilon_0 r}\left(\frac{1}{2} - 1\right)$

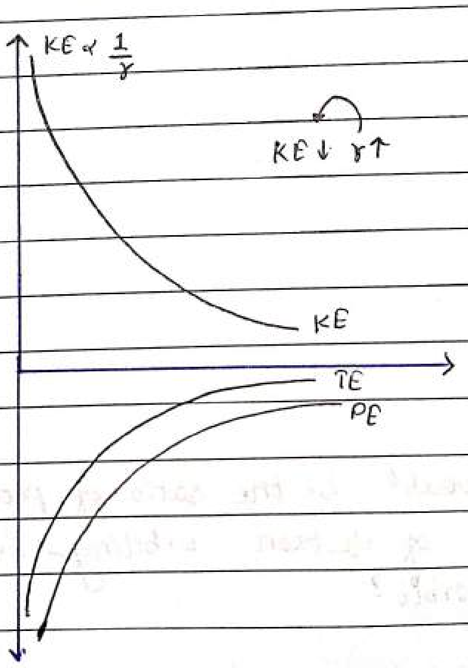
$TE = -\frac{Ze^2}{8\pi\epsilon_0 r} = -KE$

$TE = -KE$

$PE = -2\,KE$

$PE = 2\,TE$

$\frac{KE}{TE} = 1:-1$



$$TE = \frac{-Ze^2}{8\pi\epsilon_0 r}$$

$$TE = \frac{-Ze^2 \cancel{\pi} me^2 Z}{8\cancel{\pi}\epsilon_0 (\epsilon_0 h^2) n^2}$$

$$TE = \frac{-me^4 Z^2}{8\epsilon_0^2 h^2 n^2}$$

$$TE = -13.6\,eV\left(\frac{Z^2}{n^2}\right)$$

$TE \propto Z^2$

$TE \propto \frac{1}{n^2}$

Q. Which of the following can be the angular momentum of an electron orbiting in a hydrogen atom.

a) $\frac{4h}{2\pi}$

b) $\frac{3h}{2\pi}$

c) $\frac{3h}{4\pi}$

d) $\frac{h}{\pi}$

Q. What would be the ratio of product of velocity and time period of electron orbiting in 2nd and 3rd stable orbit.?

Ans $v \times r \propto \frac{Z}{n} \times \frac{n^3}{Z^2} \propto \frac{n^2}{Z}$

$$\frac{(vr)_{2nd}}{(vr)_{3rd}} = \frac{4}{9}$$ Ans

Q What would be the change in radius of nth orbit, if the mass of an electron reduces to half of its original value?

Ans $\frac{mv^2}{r} = \frac{Ze^2}{4\pi\epsilon_0 r^2}$

$r = \frac{Ze^2}{4\pi\epsilon_0 m v^2}$ [velocity is fixed for an orbit]

∴ radius will become double

Q The angular momentum of an electron in a hydrogen atom is proportional to (where r is radius of orbit)

A) $1/\sqrt{r}$

b) $1/r$

c) $\sqrt{r}$

d) $1/\sqrt[3]{r}$

Ans $L = mvr = \frac{nh}{2\pi}$

$L = mvr$

$L = m\left(\frac{Ze^2}{4\pi\epsilon_0 r m}\right)^{1/2} r$

$L \propto \frac{r}{\sqrt{r}} \propto \sqrt{r}$

Q When a hydrogen atom is raised from the ground state to third state then what about U and KE.

Ans KE decreases
U increases

Q

DEFINITIONS VALID FOR SINGLE ELECTRON SYSTEM

1) Ground state :- Lowest energy state of any atom or ion is called ground state of the atom.

Ground state energy of H-atom $\Rightarrow -13.6$ eV
$Z=2$ " " " " He^+ atom $\Rightarrow -54.4$ eV
$Z=3$ " " " " Li^{++} atom $\Rightarrow -122.4$ eV

$$TE = -13.6 \frac{Z^2}{n^2} \text{ eV}$$

For hydrogen atom

1^{st} excited state / 2^{nd} orbit $n=2$
$TE = -3.4$ eV
2^{nd} excited state / 3^{rd} orbit $n=3$
$TE = -1.51$ eV
3^{rd} excited orbit / 4^{th} orbit
$TE = -0.85$ eV
4^{th} excited state / 5^{th} orbit
$TE = -0.54$ eV

Q What is the angular momentum of an electron in Bohr's hydrogen atom whose energy is -3.4 eV ?

a) $\frac{h}{\pi}$

b) $\frac{2h}{\pi}$

c) $\frac{h}{2\pi}$

d) $\frac{1}{4}$

Q The angular speed of electron in the nth orbit of hydrogen atom is.

a) Directly proportional to n^2
b) Directly proportional to n
c) Inversely proportional to n^3
d) Inversely proportional to n

Ans $v = r\omega$

$\omega = \frac{v}{r} = \frac{1}{n \times n^2}$

$\omega \propto \frac{1}{n^3}$

Q Consider 3rd orbit of He^+ (Helium) using non relativistic approach, the speed of electron in this orbit will be.

Ans $v = \frac{v_0 Z}{n} = 2.2\times10^6 \times \frac{2}{3} = 1.46\times10^6$ m/s

Q When a hydrogen atom emits a photon of energy 12.09 eV its orbital angular momentum changes by

a) $\frac{3h}{2\pi}$

b) $\frac{2h}{\pi}$

c) h/π

d) $4h/\pi$

Ans

$-0.85\,eV$

$-1.51\,eV$

$-3.4\,eV$

$-13.6\,eV$

Δ Energy gap = photon = 12.09 eV

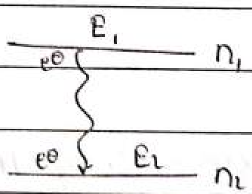
$\therefore n_1 = 1$

$n_2 = 3$

$\therefore \Delta$ Angular momentum $\Rightarrow \frac{3h}{2\pi} - \frac{h}{2\pi} = \frac{h}{\pi}$ **Ans**

Energy spectrum

$$TE \text{ (of } n_1 \text{ orbit)} = \frac{-m e^4 Z^2}{8 \epsilon_0^2 h^2 n_1^2}$$



$$TE \text{ (of } n_2 \text{ orbit)} = \frac{-m e^4 Z^2}{8 \epsilon_0^2 h^2 n_2^2}$$

$\Delta E = E_1 - E_2$

$$\Delta E = \frac{me^4 Z^2}{8\epsilon_0^2 h^2}\left(\frac{1}{n_2^2} - \frac{1}{n_1^2}\right)$$

$$E_p = \frac{hc}{\lambda} = \frac{me^4 Z^2}{8\epsilon_0^2 h^2}\left(\frac{1}{n_2^2} - \frac{1}{n_1^2}\right)$$

$E_1 - E_2 =$ photon energy

$$\frac{1}{\lambda} = \frac{me^4 Z^2}{8\epsilon_0^2 h^3 c}\left(\frac{1}{n_2^2} - \frac{1}{n_1^2}\right)$$

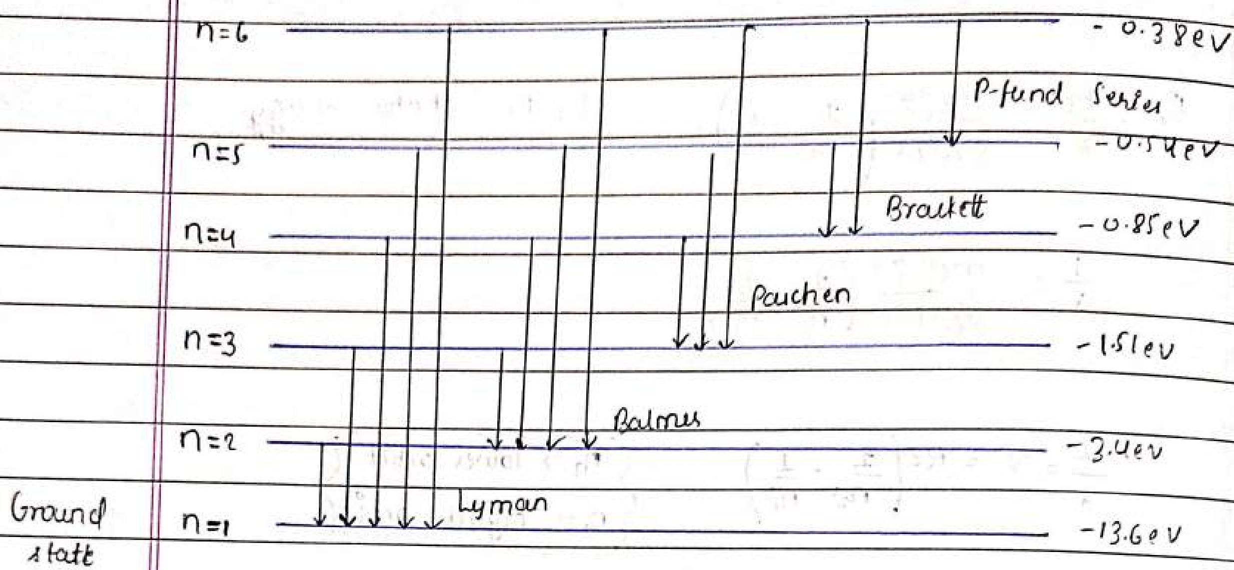
$$\frac{1}{\lambda} = \nu = RZ^2\left(\frac{1}{n_2^2} - \frac{1}{n_1^2}\right)$$

$n_2 \Rightarrow$ lower orbit
$n_1 \Rightarrow$ higher orbit

$$\frac{1}{R} = 912 \mathring{A}$$

$$R = 1.1 \times 10^{+7}\ m^{-1}$$

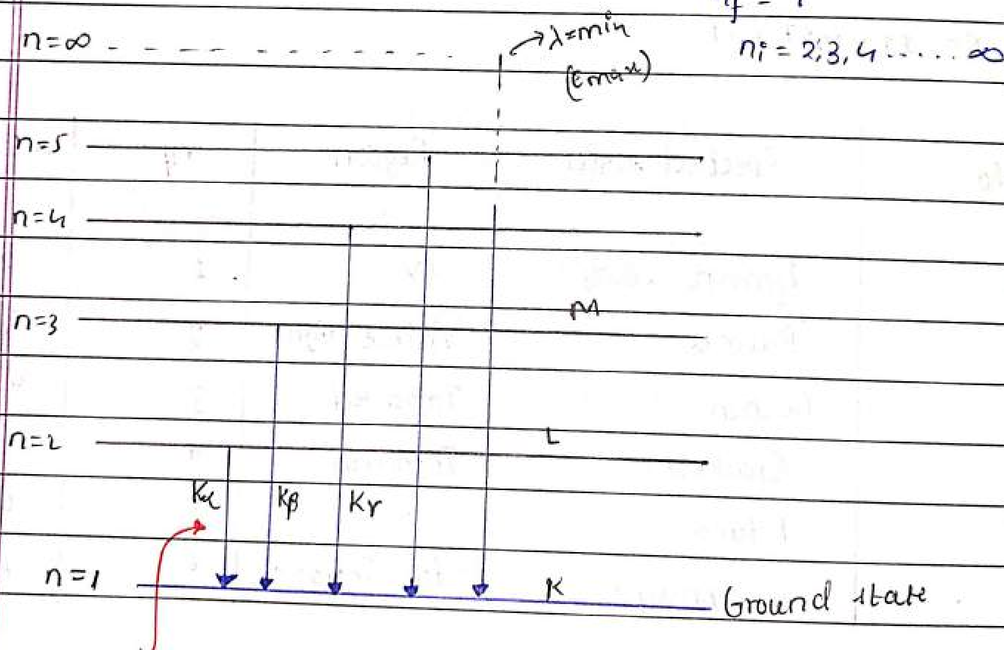
S.No	Spectral series	Region	n_f	n_i
1.	Lyman series	UV	1	2, 3, 4 ... ∞
2	Balmer "	Visible light	2	3, 4, 5 ... ∞
3	Paschen "	Infra red	3	4, 5, 6 ... ∞
4	Brackett "	Infra-red	4	5, 6, 7 ... ∞
5	P-fund	"	5	6, 7, 8 ... ∞
6	Humphrey "	far Infrared	6	7, 8, 9 ... ∞



Lyman series.

$n_f = 1$

$n_i = 2, 3, 4 \ldots \infty$



1st line

α line

λ_{max}

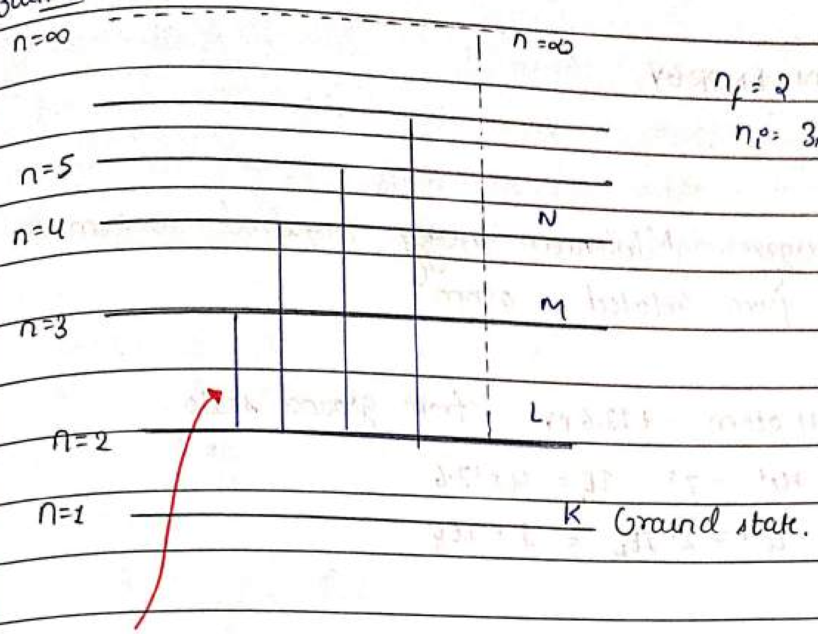
f_{min}

E_{min}

Balmer Series

$n_f = 2$

$n_i = 3, 4, 5, 6 \dots \infty$

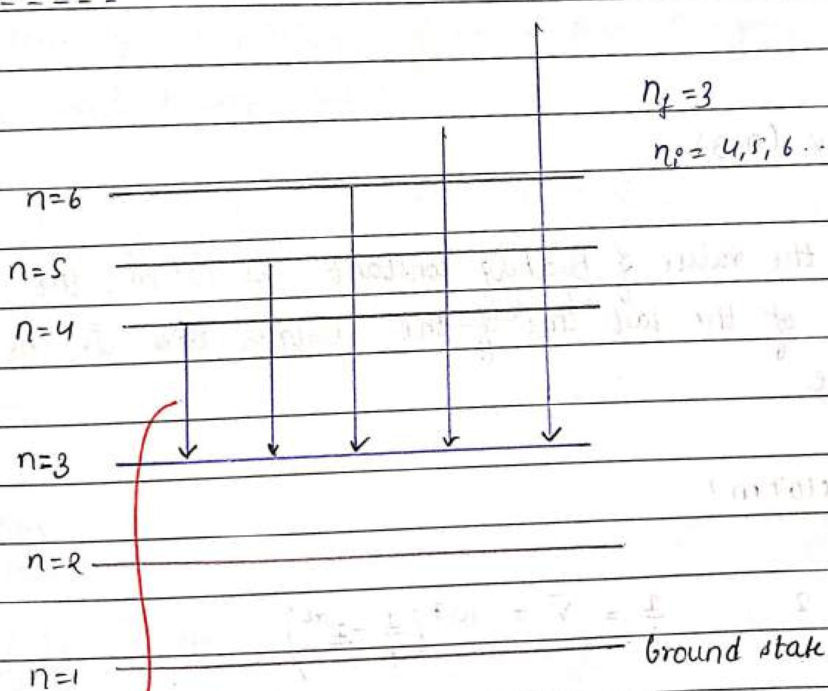


1st line
α-line
λ_{max}
f_{min}

Paschen series

$n_f = 3$

$n_i = 4, 5, 6 \dots \infty$



1st line
α line
λ_{max}

IONISATION ENERGY

Ionisation energy :- Minimum energy required to remove an e^0 from isolated atom.

IE for H atom $= +13.6\ eV$ from ground state

IE for $He^+ = Z^2\ IE_H = 4 \times 13.6$

IE for $Li^{2+} = Z^2\ IE_H = 9 \times IE_H$

Q The ground state energy of H atom is $-13.6\ eV$. The energy needed to ionise H-atom from its second excited state is

a) 1.51 eV
b) 3.4 eV
c) 13.6 eV
d) 12.1 eV

Ans 1.51 eV $(n=3)$

Q Given the value of Rydberg constant is $10^7\ m^{-1}$, the wave number of the last line of the Balmer series in H_2 spectrum will be.

a) $0.25 \times 10^7\ m^{-1}$

Ans $n_2 = 2$, $n_1 = \infty$

$$\frac{1}{\lambda} = \bar{\nu} = 10^7\left(\frac{1}{4} - \frac{1}{\infty}\right)$$

$\Rightarrow 0.25 \times 10^{-7}\ m^{-1}$ Ans

Q If an electron in a H_2 atom jumps from the 3rd orbit to the 2nd orbit, it emits a photon of wavelength λ. When it jumps from the 4th orbit to the 3rd orbit the corresponding wavelength of the photon will be.

Ans $\frac{\lambda_2}{\lambda_1} = \frac{\frac{1}{4} - \frac{1}{9}}{\frac{1}{9} - \frac{1}{16}} = \frac{5 \times \cancel{144}\,4}{\cancel{36} \times 7}$

$\lambda_2 = \frac{20}{7}\lambda$ Ans

Q As the n increases, the difference of energy between the consecutive energy is

→ decreases

Q The ratio of minimum to maximum wavelength of radiation emitted by transition of an electron to ground state of Bohr's hydrogen atom is

Ans $\frac{\frac{1}{\lambda_{min}} = \left(\frac{1}{(1)^2} - \frac{1}{(\infty)^2}\right)}{\frac{1}{\lambda_{max}} = \frac{1}{(1)^2} - \frac{1}{(2)^2}}$ λ_{min} = Max^m energy

$\frac{\lambda_{max}}{\lambda_{min}} = \frac{4}{3}$

$\frac{\lambda_{min}}{\lambda_{max}} = \frac{3}{4}$ Ans

Q The ratio of wavelength of the last line of Balmer series and the last line of Lyman series, is.

Ans $\frac{1}{\lambda_b} = \left(\frac{1}{4} - \frac{1}{\infty}\right)$

$\frac{1}{\lambda_L} = \left(1 - \frac{1}{\infty}\right)$

$\frac{\lambda_b}{\lambda_L} = 4$ Ans

Q In Bohr's model of the H_2 atom, the ratio between the period of revolution of an electron in the orbit of $n=1$ to the period of revolution of the electron in the orbit $n=2$ is.

Ans $T \propto n^3$

$\frac{T_1}{T_2} = \frac{1}{8}$ Ans

Q How many times does the electron go round the first Bohr orbit in a second

↓

frequency

Ans ⇒ 6.57×10^{15} Ans

Q The ratio of energy of the H_2 atom in its first excited state to second excited state is.

(A) 1/4 ~~(c)~~ 9/4 $E \propto \frac{1}{n^2}$

(b) 1/9 (d) 4

Q In which of the following systems will the radius of the first orbit $(n=1)$ is minimum?

(a) doubly ionized lithium
(b) singly ionized helium $r \propto \frac{n^2}{z}$
(c) deuterium atom
(d) hydrogen atom

Q The energy of a hydrogen atom in a ground state is $-13.6\,eV$. The energy of a He^+ atom in the first excited state will be.

Ans $TE = -13.6 \frac{4}{4} = -13.6\,eV$ Ans

Q Which of the following transition in a H_2 atom emits a photon of lowest frequency?

a) $n=2$ to $n=1$
b) $n=4$ to $n=2$
c) $n=4$ to $n=3$
d) $n=3$ to $n=1$

Ans $E \propto f$

$\Delta E \propto \Delta f$

For minimum f ΔE should be minimum

Q The energy of H_2 atom in its ground state is $-13.6\,eV$. The energy of the level corresponding to $n=5$ is.

(a) $-0.544\ eV$

(b) $-5.40\ eV$

c) $-0.85\ eV$

d) $-2.72\ eV$

Q If the electron in H_2 atom jumps from third orbit to second orbit, the wavelength of the emitted radiation is given by.

Ans
$$\frac{1}{\lambda} = R\left(\frac{1}{4} - \frac{1}{9}\right)$$

$$\frac{1}{\lambda} = \frac{R \times 5}{36}$$

$$\lambda = \frac{36}{5R}$$ Ans

Q The electron in the H_2 atom jumps from excited state $(n=3)$ to its ground state $(n=1)$ and the photon thus emitted irradiate, a photosensitive material, if the work function of the material is $5.1\ eV$, the stopping potential is estimated to be.

Ans
$$\Delta E = \cancel{+13.6} \quad \cancel{-1.89} \quad -1.51 + 13.6$$
$$= 12.1\ eV$$

$$eV = 12.1 - 5.1$$
$$eV = 7\ eV$$
$$V = 7\ V$$ Ans

Q The wavelength of first member of Balmer series in H_2 spectrum is of wavelength λ. Calculate the wavelength of first member of Lyman series in the same spectrum.

Ans
$$\frac{\frac{1}{\lambda_2}}{\frac{1}{\lambda_1}} = \frac{\left(\frac{1}{1}-\frac{1}{4}\right)}{\left(\frac{1}{4}-\frac{1}{9}\right)}$$

$$\frac{\frac{1}{\lambda_2}}{\frac{1}{\lambda}} = \frac{\frac{3}{\cancel{4}}}{\frac{5}{\cancel{36}\,9}} = \frac{27}{5}$$

$$\frac{\lambda}{\lambda_2} = \frac{27}{5}$$

$$\lambda_2 = \frac{5}{27}\lambda \quad \text{Ans}$$

Q Ratio of longest wavelength corresponding to Lyman and Balmer series in H_2 spectrum is.

Ans
$$\frac{1}{\lambda_L} = \left(1-\frac{1}{4}\right)$$

$$\frac{1}{\lambda_B} = \left(\frac{1}{4}-\frac{1}{9}\right)$$

$$\frac{\lambda_B}{\lambda_L} = \frac{3 \times \cancel{36}\,9}{\cancel{4} \times 5} = \frac{27}{5}$$

$$\frac{\lambda_L}{\lambda_B} = \frac{5}{27} \quad \text{Ans}$$

Q Which state of triply ionised (Be^{3+}) has the same orbital radius as that of the ground state of H_2?

Ans $\frac{r_0 n_2^2}{z_1} = \frac{r_0 n_1^2}{z_2^2}$

$\frac{1}{1} = \frac{n^2}{4}$

$n = 2$ Ans

Q The radius of the first permitted Bohr's orbit, for the electron, in a hydrogen atom equals 0.51 Å and its ground state energy equals −13.6 eV. If the electron in the H_2 atom is replaced by muon (μ^-) [charge same as electron and mass 207 m_e] the first Bohr radius and ground state energy will be.

Ans $E \propto \frac{1}{1} m$

$r \propto \frac{1}{m}$

$\therefore r_f = 2.56 \times 10^{-13} m$

$E_f = -2.8$ keV Ans

$$\frac{1}{\lambda} = \frac{me^4}{8\epsilon_0^2 h^3 c}\left(\frac{1}{n_2^2} - \frac{1}{n_1^2}\right)$$

$$\frac{hc}{\lambda} = \frac{me^4}{8\epsilon_0^2 h^2}\left(\frac{1}{n_2^2} - \frac{1}{n_1^2}\right)$$

$E \propto m$

Q Energy levels A, B, C of a certain atom corresponding to increasing values of energy i.e. $E_A < E_B < E_C$. If λ_1, λ_2, and λ_3 are wavelengths of radiations corresponding to transitions C to B, B to A and C to A respectively, which of the following relations is correct

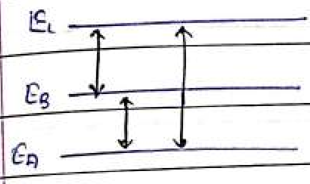
a) $\lambda_3 = \lambda_1 + \lambda_2$

b) $\lambda_3 = \dfrac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$

c) $\lambda_1 + \lambda_2 + \lambda_3 = 0$

d) $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

Ans



$$E_{C\to A} = E_{C\to B} + E_{B\to A}$$

$$\frac{hc}{\lambda_3} = \frac{hc}{\lambda_1} + \frac{hc}{\lambda_2}$$

$$\lambda_3 = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2} \quad \text{Ans}$$

Spectral Series of Hydrogen atom.

It has been shown that the energy of the outer orbit is greater than the energy of the inner one.

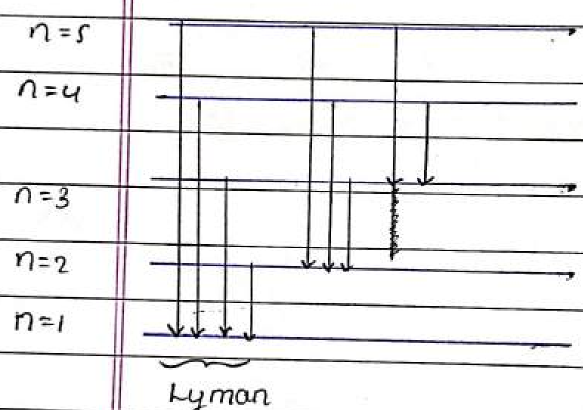
Absorption spectrum: When the Hydrogen atom is subjected to external energy, the electron jumps from lower energy state i.e Hydrogen atom is excited.

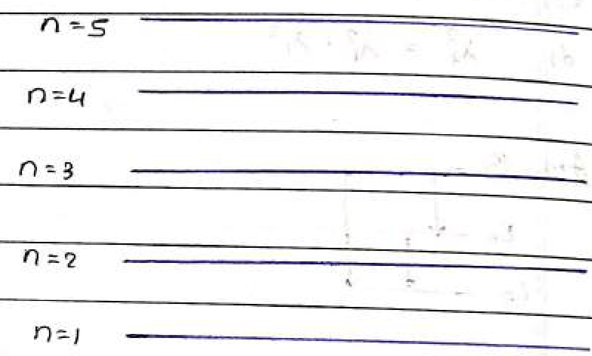
Emission spectrum

The excited state is unstable hence the electron return to its ground state in about 10^{-8} sec.

The excess of energy is now radiated in the form of radiations of different wavelength.

The different wavelength constitute spectral series.





Emission spectrum

$E_{photon} = 10.2 eV$ ✓

$E_p = 7 eV$ ×

$E_p = 11.2 eV$ ×

Photon Atom collision

Elastic - (KE conserved)

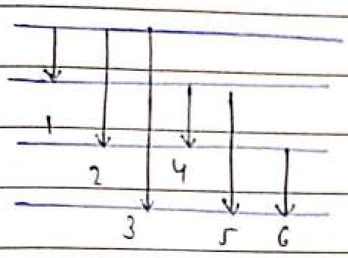
$E_p < 10.2 eV$

Inelastic (KE not conserved)

$E_p = 10.2 eV$

$E_p = 12.09 eV$

For this emission spectrum, for which line absorption spectrum also exist?



⇒ 3,5,6

Q An electron of a stationary hydrogen atom passes from the fifth energy level to the ground level. The velocity that the atom required as a result of photon emission will be.

~~a)~~ $\frac{24hR}{25m}$ (b) $\frac{25hR}{25m}$ $m =$ mass of atom

c) $\frac{25m}{24hr}$ d) $\frac{24m}{25hr}$

Ans $P_{atom} = P_{photon}$ $\lambda = \frac{25}{24R}$

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

$mv = \frac{h \times 24R}{25}$

$v = \frac{24hR}{25m}$ Ans

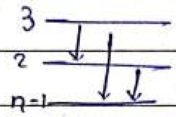
Q Ionization potential of hydrogen atom is 13.6eV. Hydrogen atoms in the ground state are excited by monochromatic radiation of photon energy 12.1 eV. According to Bohr's theory, the spectral lines emitted by hydrogen will be

(a) one (b) two

(c) three (d) four

ANS No. of spectral lines $= \frac{N(N-1)}{2}$

$$\frac{3(3-1)}{2} = 3$$



Q Hydrogen atoms are excited from the ground state to the principal quantum number 5. No. of spectral lines observed will be.

(A) 5

(B) 4

(C) 10

(d) 8

Ans $\frac{N(N-1)}{2} = 10$

Q Which is the correct relation b/w de Broglie wavelength of an electron in the nth Bohr orbit and radius of the orbit R?

ANS $2\pi R = n\lambda$

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Shivalal

DRAWBACKS OF BOHR'S MODEL

This model could not ~~effect~~ explain the fine structure of spectral line

There was a splitting of spectral line in presence of magnetic field and electric field, which could not be explained by Bohr's model.

Zeeman effect

stark effect

This is only valid for single electron atom
H, He^{+}, Li^{++}.

This model is based on circular orbits of electron but in reality there are no circular orbits.

This model could not explain the intensity of spectral lines

This model only considered particle nature of electron.