Class 11th | Chemistry

प्रारंभ BATCH

Unit : 1

Structure of Atom

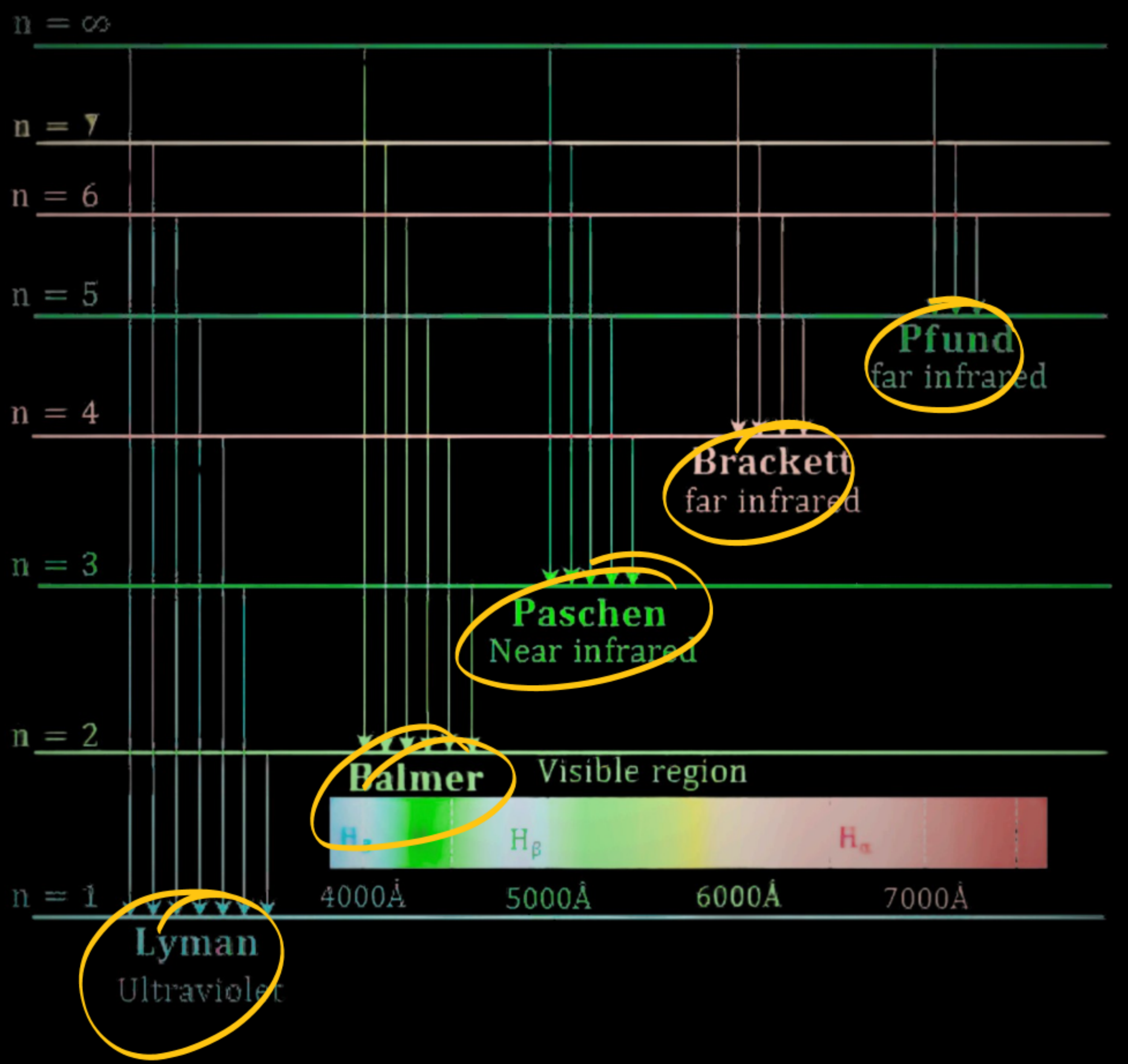
Lecture - 7

Kisi bhe shell se electron → 2nd shell.

???

(i) Series? → Balmer.

(ii) Range??? → visible


n = ∞
n = 7
n = 6
n = 5
n = 4
n = 3
n = 2
n = 1
Pfund
far infrared
Brackett
far infrared
Paschen
Near infrared
Balmer
Visible region
Hβ
Hα
4000Å
5000Å
6000Å
7000Å
Lyman
Ultraviolet

Question

For Hydrogen atom, Calculate the wavelength when electron deexcites from second shell to first shell .

Hydrogen → $Z = 1$

wavelength → Rydberg constant

$\frac{1}{R} = 911.26\,\text{Å}$

n_1 → pe

n_2 → se

Kidhar?

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

Z → At. No.

$$\frac{1}{\lambda} = R\, 1^2 \left(\frac{1}{1^2} - \frac{1}{2^2} \right)$$

$$\frac{1}{\lambda} = R \left(\frac{3}{4} \right)$$

$$\lambda = \left(\frac{1}{R} \right) \left(\frac{4}{3} \right)$$

$\frac{1}{R}$ → 911

$$\lambda = 911 \times \frac{4}{3} \Rightarrow \boxed{\lambda = 1214\,m}$$ Ans.

Series	Discovered by	regions	$n_2 \rightarrow n_1$	Number of lines
lyman	lyman	U.V. region	$n_2 = 2,3,4 \ldots / n_1=1$	$n_2 - 1$
Balmer	Balmer	Visible region	$n_2 = 3,4,5 \ldots / n_1=2$	$n_2 - 2$
Paschen	Paschen	Infra red (I.R.)	$n_2 = 4,5,6 \ldots / n_1=3$	$n_2 - 3$
Bracket	Bracket	I.R. region	$n_2 = 5,6,7 \ldots / n_1=4$	$n_2 - 4$
Pfund	Pfund	I.R. region	$n_2 = 6,7,8 \ldots / n_1=5$	$n_2 - 5$
Humphery	Humphery	far I.R. region	$n_2 = 7,8,9 \ldots / n_1=6$	$n_2 - 6$

Bohr's Atomic Model

angular momentum

- Atom has a centre called nucleus . Electrons revolve only in fixed circular orbits with fixed energy & fixed velocity .
- Quantisation condition- Electrons revolve only in those circular orbits for which their angular momentum is an integral multiple of h/2π.

Angular momentum is defined as: The property of any rotating object given by moment of inertia times angular velocity.

$$mvr = n\frac{h}{2\pi}$$

$$\frac{h}{2\pi},\ \frac{2h}{2\pi},\ \frac{3h}{2\pi},\ \frac{4h}{2\pi}$$

Bohr’s Atomic Model

- Energy is emitted or absorbed only when an electron Jumps from higher energy level to lower energy level and vice-versa.
- del E = E2 – E1 = hv = hc / lamda is known as Bohr’s frequecy rule.
- The most stable state of an atom is its ground state or normal state.

Bohr frequency Rule.

$$\Delta E = E_2 - E_1 = \frac{hc}{\lambda}$$

Postulates of Bohr's Atomic Model

1. Electrons revolve in fixed orbits:

Electrons move around the nucleus in circular paths called orbits or shells, which have specific, quantized energy levels.

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

2. Energy Levels:

Each orbit has a specific, fixed energy, and these orbits are represented by the quantum number n (n=1, 2, 3...). The closer the orbit to the nucleus, the lower its energy.

3. No Radiation:

As long as an electron remains in a specific orbit, it does not radiate energy.

Postulates of Bohr's Atomic Model

K → 2
L → 8
M → 18
N → 32

4. Energy Transitions:
Electrons can move between orbits by absorbing or emitting energy.
When an electron absorbs energy, it jumps to a higher energy level (a more distant orbit).
When an electron returns to a lower energy level, it emits energy in the form of light.

5. Quantized Angular Momentum:
The angular momentum of an electron in an orbit is quantized, meaning it can only take on specific values.

6. Maximum Occupancy:
The maximum number of electrons that can occupy an energy level (shell) is given by $2n^2$, where n is the principal quantum number.

Drawbacks of Bohr's Atomic Model

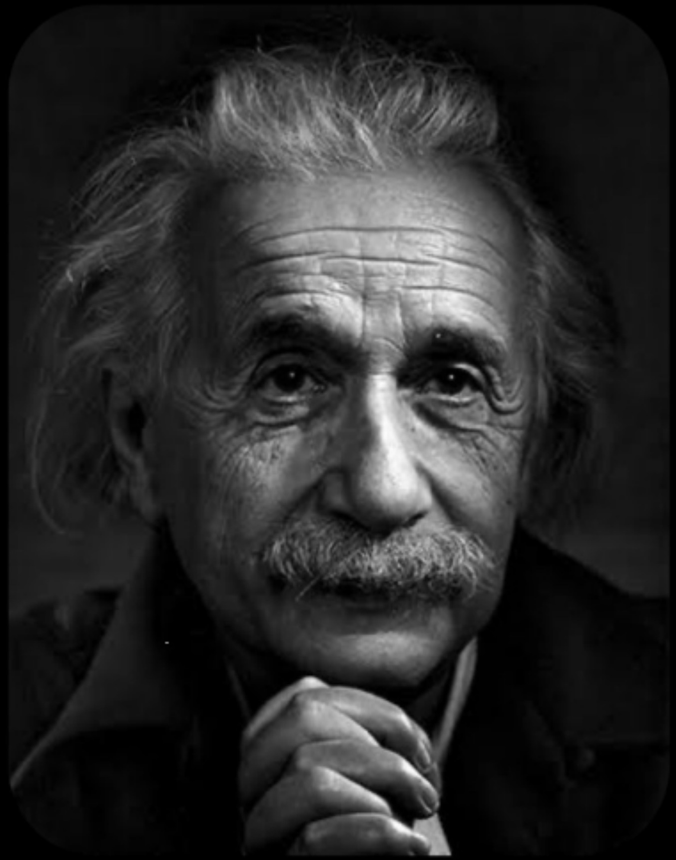
1. Limited Applicability:
   - Bohr's model is primarily successful in explaining the hydrogen atom's spectrum.
   - It struggles to accurately predict the spectra of more complex atoms with multiple electrons.

2. Inability to Explain Fine Structure:
   - Bohr's model predicts single spectral lines, but in reality, many spectral lines exhibit a fine structure (splitting into multiple lines).
   - This fine structure arises from relativistic effects and spin-orbit coupling, which Bohr's model doesn't account for.

3. Failure to Explain Zeeman and Stark Effects:
   - The Zeeman effect describes the splitting of spectral lines in a magnetic field.
   - The Stark effect describes the splitting of spectral lines in an electric field.
   - Bohr's model cannot explain either of these effects.

Albert Einstein explained the photoelectric effect in 1905:

- **Explanation –** Einstein's theory was based on the idea that light is made up of tiny packets of energy called photons. He explained that when photons with enough energy hit a metal surface, they can transfer their energy to the electrons in the metal, causing them to be ejected.

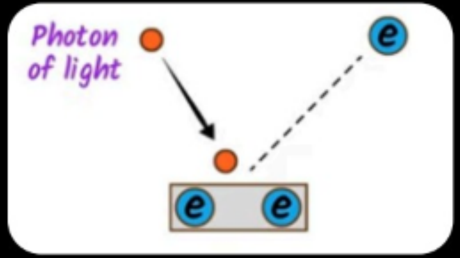


Wave Particle Nature of Light

Light → wave
→ particle (photon)

Wave
diffraction

Particle
photoelectric effect



All electromagnetic waves behave like a wave & particle

Light → wave, particle

electron → particle, wave → Yes

e → small mass, speed fast

De-Broglie Hypothesis

According to the de-Broglie hypothesis,a moving material particle behaves like a wave at times and like a particle at other times. Every moving material particle is connected with a wave.

De-Broglie Hypothesis

- De Broglie's Hypothesis says that Matter consists of both the particle nature as well as wave nature.
- De Broglie wavelengthis given as,

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

h → plank's constant 6.626×10^{-34} Js.

p → momentum.

- From the above relation, it can be said that the wavelength of the matter is inversely proportional to the magnitude of the particle's linear momentum.

De-Broglie Hypothesis

- This relation is applicable to both microscopic and macroscopic particles.
- The de Broglie equation is one of the equations that is commonly used to define the wave properties of matter.
- Electromagnetic radiation exhibits the dual nature of a particle (having a momentum) and wave (expressed in frequency, and wavelength).

e^- → particle → wave

↓

moving object

प्रारंभ BATCH

Next Toppers

De-Broglie Hypothesis

Kiliam?

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

$\lambda \propto \frac{1}{mass}$

mass ↑ → λ ↓

Ques. Why we cannot observe these waves?

Ans. Because the wavelength of their motion is extremely small

mass ↑

Maza Aagiya

Wave Particle Nature of Light

- The electrons are ejected from the metal surface as soon as the beam of light strikes the surface
- The number of electrons ejected is proportional to the intensity or brightness of light
- For each metal, there is a characteristic minimum frequency, v_o (threshold frequency) below which photoelectric effect is not observed.
- At a frequency $v > V_o$, the ejected electrons come out with certain kinetic energy.

Padh chuke hain

Photoelectric Effect

Davisson–Germer

Davisson and L.H. Germer performed an experiment known as the Davisson Germer experiment to explain the wave nature of electrons through electron diffraction.

e → mass ✓
→ velocity ✓
position ✗

Pajero car → 100 Kg, v → 80 m/s

Heisenberg's Uncertainty Principle

Heisenberg's uncertainty principle states that it is impossible to measure or calculate exactly both the position and the momentum of an object.

exact mass & velocity → momentum

position → never

Heisenberg's Uncertainty Principle

- This principle is based on the wave-particle duality of matter.
- Although Heisenberg's uncertainty principle can be ignored in the macroscopic world (the uncertainties in the position and velocity of objects with relatively large masses are negligible), it holds significant value in the quantum world.
- Since atoms and subatomic particles have very small masses, any increase in the accuracy of their positions will be accompanied by an increase in the uncertainty associated with their velocities.

Δmv or Δp → error in momentum.

Δx → error in position.

$$\Delta p \cdot \Delta x \geq \frac{h}{4\pi}$$

Δp → Δmv

Kilean?

प्रारंभ BATCH

Next Toppers

Heisenberg's Uncertainty Principle

Uncertainity in momentum

$$\Delta x \Delta p \geq \frac{h}{4\pi}$$

Uncertainity in position

Drawbacks of Bohr's atomic mode

- He could not explain the details of the Hydrogen and Helium atomic spectrum.
- He did not explain the splitting of spectral lines in presence of a magnetic field.
- The intensity of spectral lines was not explained by him.
- He considered electron as a moving particle.
- He could not explain the Zeeman effect i.e. splitting of spectral lines in Magnetic field as well as the Stark effect i.e. splitting of spectral lines in electric field.

Homework

Keliar.

\# Calculate the wavelength of a 60g ball moving with a velocity of 80 m/s

$\lambda = ???$

$m = 60g$

$v = 8 m/s$

$h = 6.626 \times 10^{-34}$

Next Toppers

Khatam !

Tata !!

Bye-Bye !!!

Fir Mileinge...