Contents

Calculation of wavelength

- The **wavelength** of lyman series is calculated using:

$$\frac{1}{\lambda} = R(\frac{1}{1^2} - \frac{1}{n^2})$$

  - R is Rydberg *constant* .
  - n is the value of orbit.

Excitation Energy

Definition

- The **excitation** energy is the amount of energy required to raise and electron from it's ground state to the corresponding excited *state* .
- The *first* excited state's excitation energy is the amount of energy required to raise the electron form ground state $n = 1$ to the **first** excited state $n = 2$.

$$E = E_2 - E_1 = -3.4eV - (-13.6eV) = 10.2eV$$

Excitation Potential

Definition

- The **excitation** potential is the amount of potential difference required to accelerate the electron from the ground state to the *corresponding* excited state.
- The *first* excitation potential is the amount of potential difference required to accelerate the electron from the *ground* state to the first *excited* state.

$$\frac{E_2 - E_1}{e} = \frac{-3.4eV - (-13.6eV)}{e} = 10.2V$$

Ionization Energy

- **Ionization Energy** is the amount of energy required to move an electron from it's **ground state** to **completely** *out* of the atom.

$$E = E_\infty - E_1 = 0 - (-13.6eV) = 13.6eV$$

Ionization Potential

- **Ionization Potential** is the amount of **potential difference** required to *accelerate* and electron from it's *ground state* to *completely out of the* **atom** .

$$V = \frac{E_\infty - E_1}{e} = \frac{0 - (-13.6eV)}{e} = 13.6V$$

Limitation of Bohr's Atomic Model

- **Bohr's atomic model** could not explain spectral lines of:
  - **multi** electron systems other than **hydrogen** and **hydrogen like** atoms.
- **Bohr's** atomic model doesnot clarify the **circular** structure of orbit of electron.
- **Zeeman Effect:**
  - **Zeeman Effect** is the splitting of spectral lines in **magnetic field** .
  - Bohr's model couldnot explain it.
- **Stark Effect:**
  - **Stark Effect** is the splitting of spectral lines in **electric field** .
  - Bohr's model couldnot explain it.
- Bohr's model couldnot explain the **wave like** character of **electron** .
- It doesnot explain the **relative** *splitting* of spectral lines.

De Broglie Hypothesis

- **Statement:** Luis Debroglie states that:
  - A moving particle has both **wave like** and **particle like** characters.
  - A moving particle is associated with **waves.**
- These waves are called:
  - Debroglie Waves
  - Matter Waves
- The **wavelength** λ of **matter waves** can be expressed as the same way for photon.

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

Calculation of wavelength of an electron

- mass = m
- potential difference for acceleration = V
- velocity of electron = v
- momentum of electron = p
- charge of electron = e
- wavelength = λ

$$\begin{aligned}
\lambda &= \frac{h}{p} \\
eV &= \frac{1}{2}mv^2 \\
v &= \sqrt{\frac{2eV}{m}} \\
\lambda &= \frac{h}{m\sqrt{\frac{2eV}{m}}} \\
\lambda &= \frac{h}{\sqrt{2meV}}
\end{aligned}$$

- The equation for expressing wavelength of **electron** is:

$$\lambda = \frac{h}{\sqrt{2meV}}$$

Heisenberg's uncertainity Principle

Canonically conjugate variables

- **Canonically conjugate** variables are:
  - pair of *physical* **variables**
  - those which can *describe* the motion of a system.
- Examples of **cannonically** conjugate variables are:
  - **Momentum** and **Position**
  - **Energy** and **Time**
  - **Angular Momentum** and **Angular Position**

Statement

- **Heisenberg's** uncertainty principle states that:
  - The pair of *physical* variables *describing* the motion of an **atomic system** cannot be measured **precisely** and **simultaneously**.

Mathematical Interpretation

- The interpretation of **canonically paired** physical variables are:

$$\triangle x \triangle p \geq \frac{h}{2\pi}$$

$$\triangle E \triangle t \geq \frac{h}{2\pi}$$

$$\triangle \theta \triangle L \geq \frac{h}{2\pi}$$

Application of Heisenberg's Uncertainty Principle

- **Heisenberg's uncertainty** principle is used to prove that the **electron** cannot exist inside the **nucleus** .
- mass of electron = m
- planck's constant = h
- change in position = $\triangle x$
- $\triangle x$ = magnitude of radius of nucleus
- $\triangle x$ = $10^{-14} m$
- change in momentum = $\triangle p$

$$\begin{aligned}
\triangle x \triangle p &\geq \frac{h}{2\pi} \\
\triangle p &= \frac{h}{2\pi \triangle x} \\
\triangle v_x &= \frac{h}{2\pi \triangle x m} \\
\triangle v_x &= \frac{6.62 \times 10^{-34}}{2 \times 3.14 \times 9.1 \times 10^{-31} \times 10^{-14}} \\
\triangle v_x &= 1.16 \times 10^{10} m/s
\end{aligned}$$

- This magnitude of velocity is *unattainable* .
- The speed limit in the universe is $3 \times 10^8 m/s$.