CONCEPT MAP

ATOMIC MODELS

Class XI

Nearly all properties of matter can be explained in terms of atoms consisting of electrons, protons and neutrons and the various models given to describe the structure of atom are based on classical, quantum and wave mechanical concepts.

Thomson atomic model or plum pudding model by J.J. Thomson, 1898

Key points

- Atoms are uniform spheres of positive electricity in which electrons are embedded.
- Stability of atom is due to the balance between the repulsive forces between the electrons and their attraction towards the centre of the positive charge.

Drawbacks

- Unable to explain the results of scattering experiment.

Rutherford's Atomic Model, 1911

Key points

- Tiny, very dense, positive nucleus surrounded by diffused electron cloud.
- Electrons move around the nucleus with high speed in a circular path called 'orbit'.
- Radius of nucleus is given by $R = R_0\sqrt[3]{A}$ cm
  where R = Radius of nucleus, $R_0 = 1.33 \times 10^{-13}$ cm, A = Mass number
- Volume of nucleus = 10^{-15} × Volume of atom

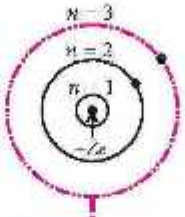
Drawbacks

- Unable to explain stability of atom.
- Unable to explain the line spectra of elements.
- Unable to describe distribution of electrons and energies of electrons.

Important Terms

- Atomic number (Z) = No. of protons = No. of electrons in a neutral atom
- Mass number (A) = No. of protons (Z) + No. of neutrons (n)
- *Isobars* have different atomic numbers but same mass numbers.
- *Isotopes* have same atomic number but different mass numbers.

Bohr's atomic model or quantized shell model, 1913



Key points

- Electrons move around the nucleus in circular orbits of fixed energy and size.
- An electron can jump between these orbits by absorbing or emitting energy.
- The energy difference between two states is given by, $\Delta E = E_2 - E_1$
- It explains the stability of atom and the line spectrum of hydrogen.

For hydrogen and hydrogen like particles

- Energy (E_n) = $\dfrac{-1312\,Z^2}{n^2}$ kJ/mol
- Radius (r_n) = $\dfrac{0.529\,n^2}{Z}$ Å
- Speed (v_n) = $\dfrac{2.18 \times 10^8}{n} \times Z$ cm/sec

Quantum Mechanical Model

Key points

- An atomic orbital is the wave function (Ψ) for an electron in an atom and Ψ^2 (probability density) gives the probability of finding an electron around the nucleus.
- It is based on
  - de Broglie relation : $\lambda = \dfrac{h}{mv}$
  - Heisenberg's uncertainty principle : Product of uncertainty in the position (Δx) and uncertainty in the momentum (Δp) is always constant.

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

Drawbacks

- Unable to explain the spectra of multielectron atoms.
- Unable to explain fine spectra of hydrogen.
- Unable to explain Zeeman and Stark effects.