CHAPTER

02

Structure of Atom

A Quick Recapitulation of the Chapter

1. **Atoms** can be further divided into sub-atomic particles like electrons, protons and neutrons.
2. **Atomic number** is equal to number of protons present in the nucleus of an atom.
3. **Isobars** are the atoms with the same mass number but different atomic number whereas isotopes are the atoms with identical atomic number but different mass number.
4. Atoms of different elements containing same number of neutrons are called **isotones** and species having same number of electrons are called **isoelectronic**.
5. According to **Maxwell's wave theory** energy is emitted continuously from any source in the form of radiations travelling in the form of waves and are associated with electric and magnetic fields perpendicular to each other and to the direction of propagation.
6. **Frequency** (ν) number of waves that pass a given point in one second is called frequency.
7. **Wavelength** (λ) It is the distance between any two con-secutive crests or troughs.
8. **Velocity** (c) It is the linear distance travelled by a wave in one second. In vacuum all types of electromagnetic waves travel with same speed.
9. **Wave number** ($\bar{\nu}$) is defined as the number of wavelengths per unit length and its unit is m^{-1}.
10. **Black body radiation** The ideal body, which emits and absorbs all frequencies, is called a black body and emitted the radiation by such body is called black body radiation.
11. **Planck's quantum theory** Atoms and molecules can emit energy only in discrete quantities and not in a continuous manner.
12. **Photoelectric effect** is a phenomenon in which ejection of electrons takes place when certain metals (K, Rb, Cs etc) are exposed to a beam of light having certain minimum frequency (ν_B).
13. **Rydberg formula** For hydrogen and hydrogen like particles $\frac{1}{\lambda} = \bar{\nu} = R_H\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]Z^2$
14. **Bohr's model of atom**
    Angular momentum of an electron, $mvr = \frac{nh}{2\pi}$
15. Radius of stationary state of hydrogen-like species
    $$r_n = \frac{n^2}{Z} \times 52.9 \text{ pm} = n^2 a_0$$
    a_0 = Bohr's radius
16. Velocity of electron in nth shell of hydrogen-like species.
    $$v_n = \frac{Z}{n} \times 2.188 \times 10^8 \text{ cm/s}$$
17. **Ionisation energy**, $E_\infty - E_n = \frac{Z^2}{n^2} \times 2.18 \times 10^{-18}$ J/atom
18. **de-Broglie equation**, $\lambda = \frac{h}{p} = \frac{h}{mv} = \frac{h}{\sqrt{2mE_K}} = \frac{h}{\sqrt{2mqv}}$
19. **Heisenberg's uncertainty principle**, $\Delta x \times \Delta p \geq \frac{h}{4\pi}$
    Or $\Delta x \times \Delta v \geq \frac{h}{4\pi m}$
20. **Schrodinger's wave equation**
    $$\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} + \frac{8\pi^2 m}{h^2}(E - \bar{v})\psi = 0$$
21. **Quantum numbers** A set of four quantum numbers which gives complete information about any electron in an atom.
22. **Principal quantum number** (n) determines the size and the energy of the orbital.

23. **Azimuthal quantum number** (l) is also known as **orbital angular momentum** or **subsidiary quantum number**. It gives information about the three dimensional shape of the orbital.
24. **Magnetic orbital quantum number** (m_l) gives information about the spatial orientation of the orbital with respect to standard set of coordinate axis.
25. **Spin quantum number** (m_s) refers to orientation of the spin of the electron, i.e. clockwise or anti-clockwise
26. **Aufbau principle** In the ground state of the atoms, the orbitals are filled in order of their increasing energies. *1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s.*
27. **Pauli exclusion principle** No two electrons in an atom can have the same set of four quantum numbers.

    It can also be stated as

    "Only two electrons may exist in the same orbital and these electrons must have opposite spin".
28. **Hund's rule** of maximum multiplicity. Pairing of electrons in the orbitals belonging to the same subshell (*p*, *d* or *f*) does not take place until each orbital belonging to that subshell has got one electron each, i.e. it is singly occupied.