Chemistry Study Materials for Class 11 (NCERT Based Revisions of Chapter- 02)

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Structure of Atom

Electromagnetic radiations:

The radiations which are associated with electrical and magnetic fields are called electromagnetic radiations. When an electrically charged particle moves under acceleration, alternating electrical and magnetic fields are produced and transmitted. These fields are transmitted in the form of waves. These waves are called electromagnetic waves or electromagnetic radiations.

Properties of electromagnetic radiations:

- Oscillating electric and magnetic field are produced by oscillating charged particles. These fields are perpendicular to each other and both are perpendicular to the direction of propagation of the wave.
- They do not need a medium to travel. That means they can even travel in vacuum.

Characteristics of electromagnetic radiations:

- **Wavelength:** It may be defined as the distance between two neighbouring crests or troughs of wave as shown. It is denoted by λ.
- **Frequency (v):** It may be defined as the number of waves which pass through a particular point in one second.
- **Velocity (v):** It is defined as the distance travelled by a wave in one second. In vacuum all types of electromagnetic radiations travel with the same velocity. Its value is 3×10^8 m $sec^{-1.}$ It is denoted by v
- Wave number: Wave number is defined as the number of wavelengths per unit length.

Velocity = frequency x wavelength $c = v\lambda$

Planck's Quantum Theory-

- The radiant energy is emitted or absorbed not continuously but discontinuously in the form of small discrete packets of energy called 'quantum'. In case of light , the quantum of energy is called a 'photon'
- The energy of each quantum is directly proportional to the frequency of the radiation, i.e. E α v or E= hv

  where h= Planck's constant = 6.626×10^{-27} Js
- Energy is always emitted or absorbed as integral multiple of this quantum. E= nhv Where n=1,2,3,4,.....

Black body: An ideal body, which emits and absorbs all frequencies, is called a black body. The radiation emitted by such a body is called black body radiation.

Photoelectric effect: The phenomenon of ejection of electrons from the surface of metal when light of suitable frequency strikes it is called photoelectric effect. The ejected electrons are called photoelectrons.

Experimental results observed for the experiment of Photoelectric effect-

- When beam of light falls on a metal surface electrons are ejected immediately.
- No. of electrons ejected is proportional to intensity or brightness of light
- Threshold frequency (vo): For each metal there is a characteristic minimum frequency below which photoelectric effect is not observed. This is called threshold frequency.
- If frequency of light is less than the threshold frequency there is no ejection of electrons no matter how long it falls on surface or how high is its intensity.

Photoelectric work function (Wo): The minimum energy required to eject electrons is called photoelectric work function. Wo= hvo

Energy of the ejected electrons: $h(\nu - \nu_0) = \frac{1}{2} m_e v^2$

Dual behavior of electromagnetic radiation- The light possesses both particle and wave like properties, i.e., light has dual behavior. Whenever radiation interacts with matter, it displays particle like properties.(Black body radiation and photoelectric effect) Wave like properties are exhibited when it propagates(interference an diffraction)

- When a white light is passed through a prism, it splits into a series of coloured bands known as spectrum.
- Spectrum is of two types: continuous and line spectrum
  - The spectrum which consists of all the wavelengths is called continuous spectrum.
  - A spectrum in which only specific wavelengths are present is known as a line spectrum. It has bright lines with dark spaces between them.
- Electromagnetic spectrum is a continuous spectrum. It consists of a range of electromagnetic radiations arranged in the order of increasing wavelengths or decreasing frequencies. It extends from radio waves to gamma rays.
- Spectrum is also classified as emission and line spectrum.
  - Emission spectrum: The spectrum of radiation emitted by a substance that has absorbed energy is called an emission spectrum.
  - Absorption spectrum is the spectrum obtained when radiation is passed through a sample of material. The sample absorbs radiation of certain wavelengths. The wavelengths which are absorbed are missing and come as dark lines.

The study of emission or absorption spectra is referred as spectroscopy.

Spectral Lines for atomic hydrogen:

Series	n_1	n_2	Spectral Region
Lyman	1	2, 3, 4, 5 ...	Ultraviolet
Balmer	2	3, 4, 5 ...	Visible
Paschen	3	4, 5 ...	Infrared
Brackett	4	5, 6 ...	Infrared
Pfund	5	6, 7...	Infrared

- Rydberg equation

$$\bar{\nu} = 109{,}677 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \ cm^{-1}$$

R = Rydberg's constant = 109677 cm^{-1}

Bohr's model for hydrogen atom:

- An electron in the hydrogen atom can move around the nucleus in a circular path of fixed radius and energy. These paths are called orbits or energy levels. These orbits are arranged concentrically around the nucleus.
- As long as an electron remains in a particular orbit, it does not lose or gain energy and its energy remains constant.
- When transition occurs between two stationary states that differ in energy, the frequency of the radiation absorbed or emitted can be calculated

$$\nu = \frac{\Delta E}{h} = \frac{E_2 - E_1}{h}$$

- An electron can move only in those orbits for which its angular momentum is an integral multiple of h/2π

$$m_e \, v r = n . \frac{h}{2\pi} \qquad n = 1,2,3.....$$

- The radius of the *n*th orbit is given by $r_n = \frac{52.9 \text{ pm} \times n^2}{Z}$
- Energy of electron in *n*th orbit is :

$$E_n = -2.18 \times 10^{-18} \left(\frac{Z^2}{n^2} \right) J$$

Limitations of Bohr's model of atom:

- Bohr's model failed to account for the finer details of the hydrogen spectrum.
- Bohr's model was also unable to explain spectrum of atoms containing more than one electron.

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