### CHAPTER 2 STRUCTURE OF ATOM

• Atom is the smallest indivisible particle of the matter. Atom is made of electron, proton and neutrons.

PARTICLE	ELECTRON	PROTON	NEUTRON
Discovery	Sir. J. J. Thomson	Goldstein (1886)	Chadwick (1932)
	(1869)		
Nature of charge	Negative	Positive	Neutral
Amount of charge	1.6 x 10 <sup>-19</sup> Coloumb	1.6 x 10 <sup>-19</sup> Coloumb	0
Mass	9.11 x 10 <sup>-31</sup> kg	1.672614 x 10 <sup>-27</sup> kg	1.67492 x10 <sup>-27</sup> kg

- Electrons were discovered using cathode ray discharge tube experiment.
- Nucleus was discovered by Rutherford in 1911.
- Cathode ray discharge tube experiment: A cathode ray discharge tube madeof glass is taken with two electrodes. At very low pressure and high voltage, current starts flowing through a stream of particles moving in the tube fromcathode to anode. These rays were called cathode rays. When a perforated anode was taken, the cathode rays struck the other end of the glass tube atthe fluorescent coating and a bright spot on the coating was developed

#### **Results:**

- a. Cathode rays consist of negatively charged the trans.
- b. Cathode rays themselves are not **vice Sta** their behavior can be observed with
- help of fluorescent (phosphorescent materies.

c. In absent of electrical or magned field cathode rays travel in straightents

d. In presence of lectrical or magnetic field, behaviour of cathode rays is similar to that shown by electrons

e. The characteristics of the cathode rays do not depend upon the material of the electrodes and the nature of the gas present in the cathode ray tube.

- Charge to mass ratio of an electron was determined by Thomson. The chargeto mass ratio of an electron as 1.758820 x 10<sup>11</sup> C kg<sup>-1</sup>
- Charge on an electron was determined by R A Millikan by using an oil dropexperiment. The value of the charge on an electron is  $-1.6 \times 10^{-19}$ C.
- The mass on an electron was determined by combining the results of Thomson's experiment and Millikan's oil drop experiment. The mass of anelectron was determined to be  $9.1094 \times 10^{-31}$ kg.
- **Discovery of protons and canal rays:** Modified cathode ray tube experimentwas carried out which led to the discovery of protons.
- Characteristics of positively charged particles: a. Charge to mass ratio of particles depends on gas from which these originate

- b. theelectrons undergo acceleration. According to electromagnetic theory of Maxwell, a charged particle undergoing acceleration should emittelectromagnetic radiation. Thus, an electron in an orbit should emitradiation. Thus, the orbit should shrink. But this does not happen.
- c. The model does not give any information about how electrons are distributed around nucleus and what are energies of these electrons
- **Isotopes:** These are the atoms of the same element having the same atomicnumber but different mass number.e g  $_1H^1$ ,  $_1H^2$ ,  $_1H^3$
- **Isobars:** Isobars are the atoms of different elements having the same massnumber but different atomic number.e g  $_{18}Ar^{40}$ ,  $_{20}Ca^{40}$
- **Isoelectronic species**: These are those species which have the same number of electrons.
- Electromagnetic radiations: The radiations which are associated withelectrical and magnetic fields are called electromagnetic radiations. When anelectrically charged particle moves under acceleration, alternating electricaland magnetic fields are produced and transmitted. These fields aretransmitted in the form of waves. These waves are called electromagneticwaves or electromagnetic radiations.

# • Properties of electromagnetic radiations:

- a. 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.
- b. They do not need a medium to trave. That means they can even travel in vacuum.
- Characteristics of electromagnetic radiations:
  - a. Wavelength: It may be defined as the distance between two neighbouring creats or troughs of wave as shown. It is denoted by  $\lambda$ .
    - b. **Frequency** (v): It may be defined as the number of waves which passthrough a particular point in one second.
    - c. Velocity (v): It is defined as the distance travelled by a wave in onesecond. In vacuum all types of electromagnetic radiations travel with thesame velocity. Its value is  $3 \times 10^8 \text{m sec}^{-1}$ . It is denoted by v

d. Wave number: Wave number  $(\bar{\nu})$  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.  $E \alpha v$  or E = hv where  $h = Planck's constant = 6.626 x 10^{-27} Js$
- Energy is always emitted or absorbed as integral multiple of this quantum. E=nhv Where n=1,2,3,4,.....

The electronic configuration of Cr is:  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$ The orbital picture of chromium is: t t t t t t 28 34 15 2p38 3p4s

From the orbital picture, chromium has six unpaired electrons.

(d) Iron (Fe):

Atomic number = 26The electronic configuration is:  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$ The orbital picture of chromium is: †↓ t+ t t t t 1s2s3d3p 40 From the orbital picture, iron has **four** unpaired electrons.

#### HOTS QUESTIONS WITH ANSWERS

- 1. Give the name and atomic number of the inert gas atom in which the total number of d-electrons is equal to the difference between the numbers of total p and total s electrons.
- Ans. electronic configuration of Kr ( atomic no.=36) = $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$ Total no. of s-electrons = 8, total no. of p-electrons = 18. Difference = 10No. of d- electrons = 10
- 2. What is the minimum product of uncertainty in position and in Minentum of an

3. Which orbital is non-directorial
Ans. s- orbital
4. What is all other ence between the number of 18
Ans. Trepresented Ans. represents the sub-men and L represent shell.

5. How many electrons in an atom can have n + l = 6? Ans. 18

6. An anion  $A^{3+}$  has 18 electrons. Write the atomic number of A.

Ans.15

7. Arrange the electron (e), protons (p) and alpha particle ( $\alpha$ ) in the increasing order for the values of e/m (charge/mass).

Ans.. $\alpha$