RADIOACTIVITY

- The phenomenon of spontaneous emission of radiation or particles from the nucleus is called radioactivity. The substances which emit these radiations are called as radioactive substances. It was discovered by Henry Becquerel for atoms of radium. Later it was discovered that many naturally occun•ing compounds ofheavy elements like radium, thorium etc also emit radiations.
- At present, it is known that all the naturally occurring elements having atomic number greater than 82 are radioactive. For example some of them are; radium, polonium, thorium, actinium, uranium, radon etc. Later on Rutherford found that emission of radiation always accompanied by transformation of one element (transmutation) into another. Actually radioactivity is the result of disintegration of an unstable nucleus. Rutherford studied the nature ofthese radiations and found that these mainly consist of a, ß, y rays.
- • a-Particles (2He^4) o These carry a charge of+2e and mass equal to 4m . These are nuclei of helium atoms. The energies of a-particles vary from 5 MeV to 9 MeV and their velocities vary from 0.01-0.1 times Ofc (velocity of light). They can be deflected by electric and magnetic fields and have low penetrating power but high ionizing power.
- • ß-Particles (_le^0) o These are fast moving electrons having charge equal to ₋e and mass me = 9.1 x 10 ^{31} kg. Their velocities vary from 1% to 99% of the velocity of light

(c). They can also be deflected by electric and magnetic fields. They have low ionizing power but high penetrating power. ß particles are positrons.

y-Radiation (OY^{O})

o These are electromagnetic waves of nuclear origin and of very short wavelength. They have no charge and no mass, They have maximum penetrating power and mrnimum ionising power. The energy released in a nuclear reaction is mainly emitted in the form of Y radiation.

LAWS OF RADIOACTIVE DECAY

Rutherford-Soddy Laws (Statistical Laws)

fie disintegration of a radioactive substance is random and spontaneous.

Radioactive decay is purely a nuclear phenomenon and is independent of any physical and chemical conditions,

The radioactive decay follows first order kinetics, i.e., the rate ofdecay is proponional to the number ofundecayed atoms in a radioactive substance at any time t, IfdN be the number of atoms (nuclei) disintegrating in time dt, the rate ofdecay is given as dN/dt . From first order of kinetic rate law

—— = –RN , where X is called as decay or disintegration dt constant.

- Let No be the number of nuclei at time t = 0 and N be the number of nuclei after time t, then according to integrated first order rate law, we have .

Nt = Noe It = In _L = 2.303 log —

- The half life (TIP) period of a radioactive substance is defined as the time in which one-half of the radioactive substance is disintegrated. If N be the number ofnuclei at t = 0, then in a half life T the number of nuclei decayed will be IV0/2.

$$N_t = N_0 e^{-\lambda t}$$

—— =Noe .(ii)

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From (i) and (ii), we get

t/Tl/2n

$$\frac{N_t}{N_0} = \left(\frac{1}{2}\right)$$ 1

2 n = number

of half lives

- The mean life (T) of a radioactive substance is equal to the sum of life times of all atoms divided by the number of all atoms. It is given by

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