NUCLEAR RADIATIONS 20

20.1 WILSON CLOUD CHAMBER:

It is a simple device used for the detection and identification of subatomic particles. It was developed by C.T.R Wilson. In this chamber, paths of single particles through fog or vapours can be photographed. A number of subatomic particles have been discovered by it.

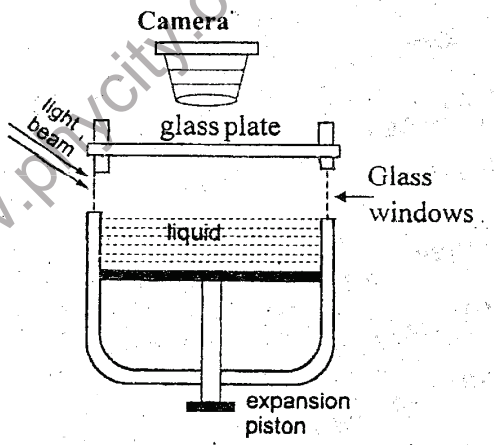
PRINCIPLE:

It is based on the principle that supersaturated vapours condense more readily on ions or dust particles.

CONSTRUCTION:

The cloud chamber consists of a closed chamber having glass top and moveable piston at its bottom. Two glass windows are provided in the walls of the chamber opposite to each other. A high volatile liquid such as alcohol is placed above the piston in the chamber. A strong source of light, subatomic particles source and high speed sensitive camera are also provided.

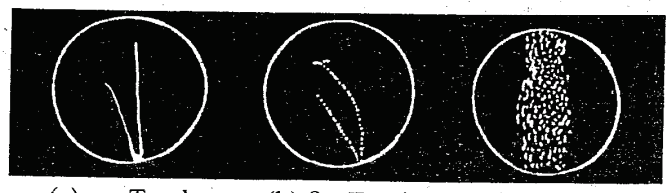
WORKING:



Some quantity of volatile liquid having low boiling point such as alcohol is placed in the chamber above the piston. The piston is at first moved up, so that the air inside the chamber is cleaned up and then it is suddenly moved down, so that the internal pressure is dropped. The vapours in the chamber are thus cooled adiabatically. The super saturated vapours condense in the form of fog. At the right moment the particle to study is allowed to enter into the chamber and an intense beam of light is used to illuminate the chamber. The ionizing particle leaves positive and negative ions all along its track and tiny fog droplets condense each ion. The whole track can be seen and photographed in bright light.

A strong electric or magnetic field can be applied to alter the path. From the path diagram of particles path length, thickness, continuity or discontinuity and the influence of magnetic field, the ionizing power, penetrating power and e/m can be determined.

The path diagrams of α, β and γ rays show that path of α-particles look like a continuous streak. It shows that the ionizing power of α-particles is very large. The path diagram of β-particles is not continuous and less prominent. It shows that their ionizing power is less than α-particles. The path diagram of γ-particles is an indefinite track which shows their weakest ionization power.



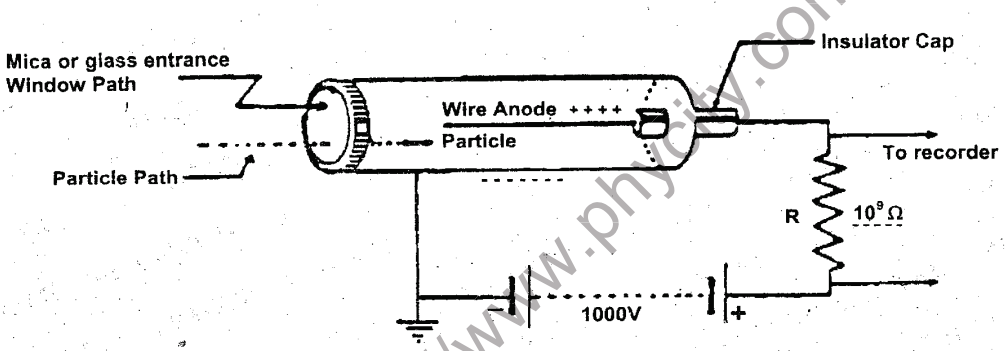
(a) α - Track (b) β - Track (c) γ - Track

20.2 GEIGER COUNTER:

The Geiger counter is widely used as a detector of Nuclear radiations. It counts the number of particles emitted from a radioactive substance and the strength of radiations. It is also used to differentiate between different types of radiations.

CONSTRUCTION:

It is a simple, small portable device. It consists of a hollow metallic cylinder, one end of which is closed by an electric insulation. At the other end there is a thin foil of mica through which radiations can enter. The cylinder usually contains a mixture of argon and alcohol at suitable pressure. A large potential difference of about 1000V is established between the cylinder wall and the wire. This gives a strong electric field in the cylinder. Cylinder walls are used as cathode and wire as anode.



WORKING:

When ionizing particles enter the counter through the window, it produces ions and electrons in the gas. These electrons are accelerated by the electric field. The accelerated ions suffer collisions with other molecules and produce further ionization. This gives rise to a discharge in the tube and the gas becomes conducting. A current starts flowing through the circuit. The voltage drops is amplified and recorded by a loudspeaker or by an electric counter. There is a mechanism in the counter which makes it again conducting and ready to record another particle. Every ionizing particle acts as a trigger. The number of particles entering the counter are recorded by the recorder. The number of counts recorded by the counter is a measure of strength of the radiations.

20.3 EFFECTS OF RADIATIONS:

When a living tissue is exposed to radiations, the energy absorbed may produce chemical changes in the cells which affect cell metabolism. Large molecules may be broken up into free radicals, capable of initiating chemical changes. These changes may become sufficient enough to damage the cells which lead to the death of cell. Which results in abnormalities in growing character of new cells.

The biological effects are generally of two types, somatic and genetic. ***Somatic effects affect an individual directly.*** Some of the common somatic effects of radiation are skin-burn, loss of hair, ulceration, stiffening of lungs, an induction of cataract in the eyes, etc. The most feared somatic effect of radiations is the induction of many types of cancer.

Radiations damage the cells of the reproductive organs of either sex thus damages the genes. This damage can be transmitted to generation after generation in the form of birth defects and abnormalities. ***Thus genetic affects affect the generations.***

20.4 RADIATION TECHNIQUES IN VARIOUS FIELDS:

Radiation techniques are widely employed for different purposes in various fields and the results are very encouraging, some of these are:

1) TRACER TECHNIQUE:

The tracer technique has made it possible to understand the chemistry of complex reactions in the biological organisms, which has helped to diagnose and to cure some unknown diseases. ${}_6C^{14}$ and ${}_1H^3$ are used in tracing digestion of various food molecules.

Tracer studies reveals that ${}_{53}I^{131}$ can be used for treating thyroid cancer, ${}_{20}Ca^{45}$ for treating bone cancer and ${}_{11}Na^{24}$ for tracing rate of flow of blood. Radio isotope ${}_6C^{14}$ is used for tracing absorption of CO_2 the seat of photosynthesis and distribution of plant food, by a technique called ***Auto-Radiography.***

2) RADIO PROCESS IN SPACE:

The new range of sensitive detectors has made it possible to analyze in details the study of cosmic rays entering the earth's atmosphere from outer space. Radio signals emanating from the stars reflect radiations of such frequencies that indicate the presence of particular types of molecules.

3) POLYMERISATION:

The radiation process in polymerization has helped to evolve new plastic materials, pesticides and some complex compounds.

4) STERILIZATION:

A beam of β-particles or gamma rays can destroy germs and is thus helpful to sterilize surgical instruments and other medical appliances.

5) FOOD PRESERVATION:

The length of time that a food material can be stored depends on the microbial activity that attacks the food and causes it to spoil. Radiation treatment has shown better results for preservation and storage of food stuff.

6) TREATMENT OF CANCER:

Radiations can destroy rapidly growing cancer cells. The process is called ***Radiation Therapy***, which is of two types:

i) EXTERNAL THERAPY: In this process cancerous cells are destroyed by passing radiations. For example in treating a localized cancerous tumour a narrow beam of gamma rays from cobalt-60 is oftenly used.

ii) INTERNAL THERAPY: In this process radioactive particles are made to enter surgically in the cancerous tumour where they remain deposited for a long time. For example radio isotope of $_{53}I^{131}$ is injected in the blood from where they deposit in thyroid glands and thus provide treatment of thyroid cancer.

7) GAUGING AND CONTROL:

In paper, glass, metal industries, a beta ray source is used to measure thickness and controlling their sheets without interrupting the production.

8) RADIATION METHODS IN ARCHAEOLOGY:

Radiation Technique made it possible to measure the age of the specimen, i.e. the time elapsed. This process is called radio-carbon dating as isotope $_6C^{14}$ called carbon date is used for this purpose.