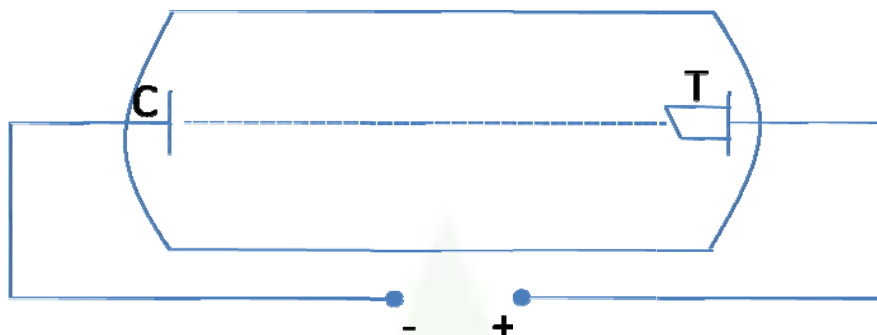




X-Ray

Passage of electricity through rarefied gases:



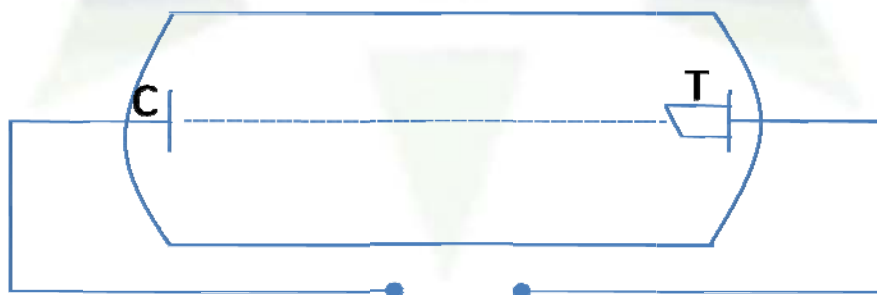
Cathode ray is a beam of very high speed electrons emitted from the cathode and move towards anode.

Properties of cathode ray:

1. Since it is a beam of charged particle when passed through an electric field it is deviated from its path.
2. Since it is beam of charged particle and it is in motion hence it produces a magnetic field around it when a beam of cathode ray is made to pass through a magnetic field it experiences a force and hence deflected.
3. This rays have an ionizing power.

X-ray: X-ray is an electromagnetic wave of very short wave length ranging from $0.1\text{\AA} \sim 100\text{\AA}$

Production of X-ray: In a discharge tube two electrodes cathode and anode are taken. A small piece of material having high atomic number and high melting point is used as target and is embedded on the anode block.



The pressure of residual gas is reduced to as low as 10^{-5} mm of Hg. On applying the potential difference 1 KV to 100 KV between the two electrodes the high speed electrons emitted from the cathode strike the target and X-ray is emitted.

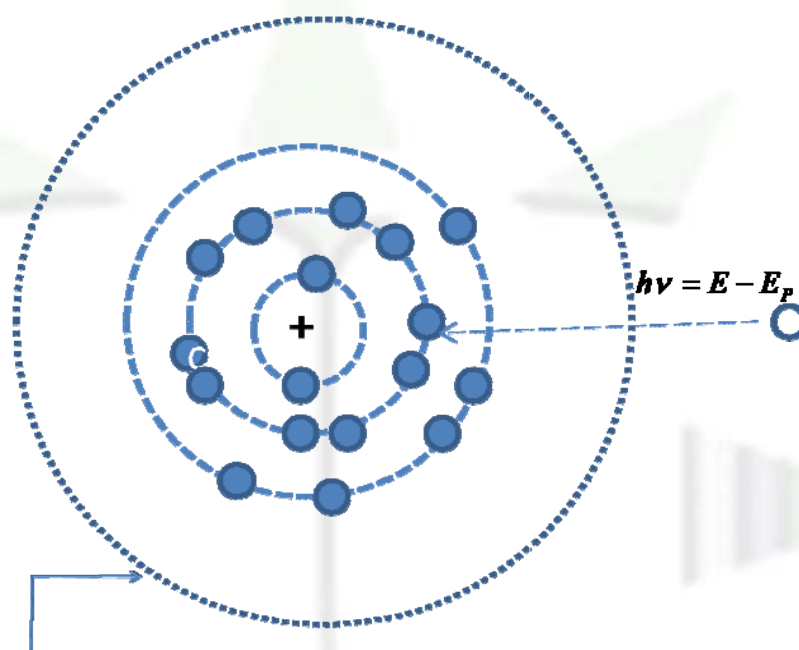
Soft X-ray: X-rays of comparatively long wave lengths are known as soft X-rays. Soft X-rays are produced when the applied potential difference in the lower range between 10 KV to 30 KV, used for clinical purpose.

X-Ray



Hard X-ray: X-rays of comparatively short wave length are known as hard X-rays, hard X-rays are produced when high potential difference from 50 KV to 100 KV is applied.

Mechanism of production of X-ray: Let us consider a high speed electron in the cathode ray, strikes the target. Let us consider an atom of the target element and the electron strikes that atom. The atom consists of a positively charged nucleus round which electrons rotate in circular orbits. These orbital electrons will have an electric field around them.



Electrical field of negatively charged orbital electrons

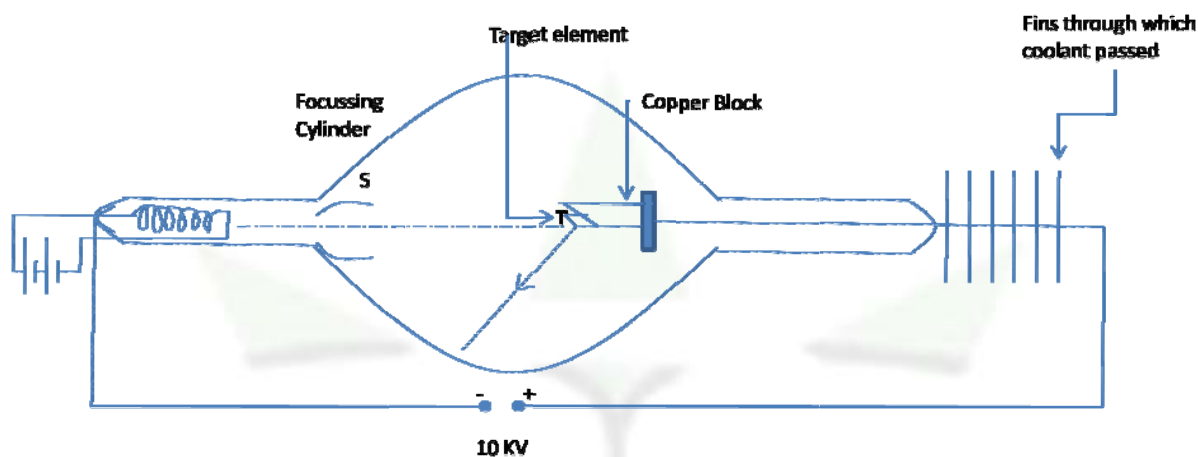
The cathode ray electrons have to pass through that electric field of those orbital electrons. When the electron enters into that electric field being negatively charge is repelled by the field and hence the motion of the electron is retarded. Thus as the cathode ray electron approaches the atom the velocity goes on decreasing and hence the electron loses K.E. Thus before striking the target atom the cathode ray electron suffers a tremendous loss in K.E within a very short time interval and the loss in K.E is emitted in the form of electro-magnetic radiation known as Bremsstrahlung.

X-ray emitted in this way is known as continuous X-ray.

The cathode ray electron then strikes the target atom and delivers its energy to the electron to which it collides. If the electron absorbs that energy its energy increases and it occupies some higher energy state, creating a vacancy in its orbit. The vacancy is soon filled up by jump of electrons from the higher energy orbit to that orbit. Each electronic transition is accompanied by emission of radiation and these radiations are known as characteristic X-ray.



X-Ray



Commercial Production of X-ray by Coolidge tube : A highly evacuated tube having a pressure up to 10^{-5} mm of Hg glass bulb is taken in which a filament F and a copper block A serving as cathode and anode are kept. The filament F is heated by passing current through it and electrons emitted. These electrons are accelerated by applying a very high Potential difference of the order of few kilovolts between the cathode and the anode. The beam of electron on its way towards the anode may get diverged due to mutual repulsion between the like charges. This is prevented by using a pair of focussing cylinder S kept at negative potential. A small piece of target element like Tungsten or Molybdenum having high atomic no and melting point is embedded in the copper block. The copper block is so arranged that the ray strikes the target at an angle of 45° and X-ray is emitted.

When the cathode ray electron strike the target only 0.2% of the incident energy is converted into X-ray and the rest is wasted and produces tremendous amount of heat energy. The heat produced is removed by passing a coolant like liquid air through the fins surrounding the anode assembly.

Properties of X-ray : X-ray is an electromagnetic wave. It is not a beam of charged particle.

1. Being an electromagnetic wave a beam of X-ray is not deflected by an electric or magnetic field.
2. X-ray has penetrating power
3. X-ray has ionising power
4. X-ray affects photographic plate

Uses: Clinical and industrial use (to find structure of crystals and faults in metal)