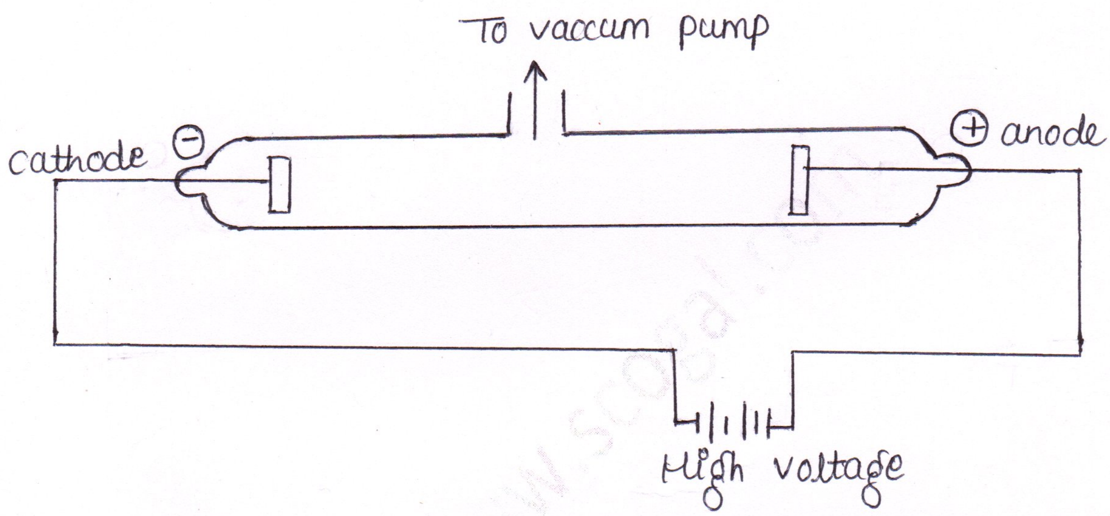
Structure of Atom

Sub-atomic particles

Discovery of Electron

Electron was discovered by J.J Thomson by Cathode ray discharge tube experiment. A cathode ray tube is made of glass containing two thin pieces of metal (electrodes) sealed in it. The electrical discharge through the gases could be observed only at very low pressures and at very high voltages.



when a very high voltage (about 10,000 volts) is applied between the two electrodes, no electric discharge occurs at normal pressure. when the pressure of gas inside the tube is less than 1 mm of mercury, a dark space appears near the cathode. when the pressure is reduced to 0.01 mm Hg, it fills the whole tube. when the pressure is further reduced, the electric discharge passes between the electrodes and the tube begins to glow. This is due to the striking of some invisible rays from the cathode. These rays which start from the cathode and move away from it, in straight lines are called **cathode rays or cathode ray particles.**

These rays can be further checked by making a hole in the anode and coating the tube behind anode with phosphorescent material like zinc sulphide. when these raysstrike the zinc sulphide coating, a bright spot on the coating is developed.

Properties of cathode Rays

i) The cathode rays start from cathode and move towards the anode.

ii) They are invisible, but their behaviour can be observed with the help of fluroscent or phosphorescent materials.

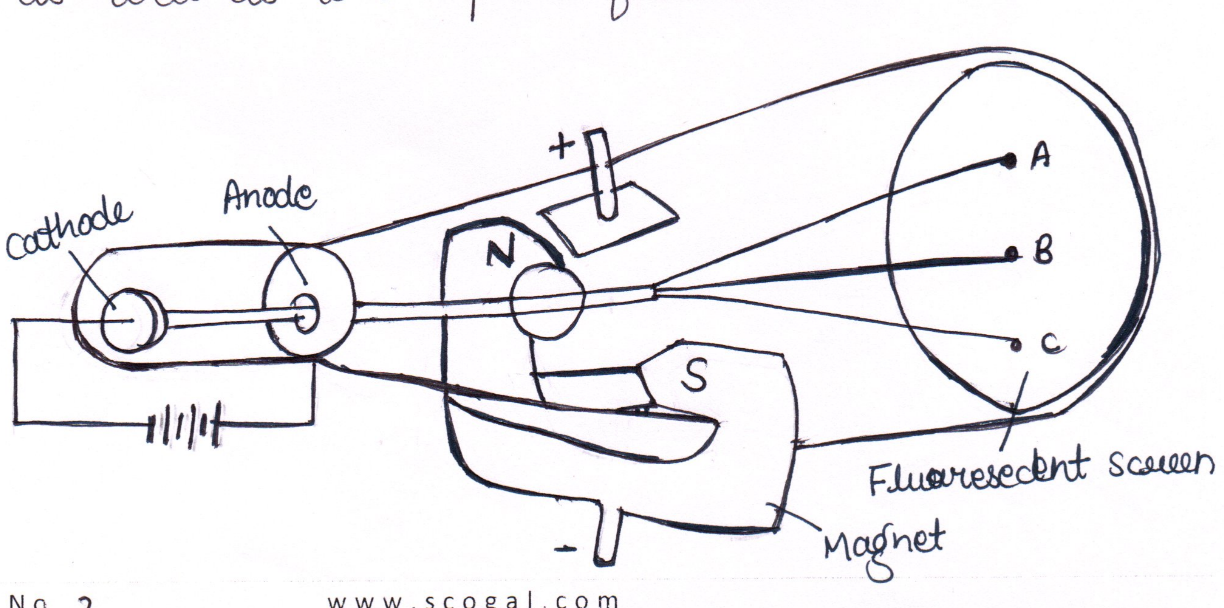
iii) In the absence of electrical or magnetic field, these rays travel in straight lines.

iv) In the presence of electrical or magnetic field, the cathode rays behave similar to that of negatively charged particles. From this it is clear that the cathode rays consist of negatively charged particles called electrons.

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

Charge to Mass Ratio of Electron

J.J Thomson measured the ratio of electrical charge (e) to the mass of electron (me) by using cathode ray tube and applying electrical and magnetic field perpendicular to each other as well as to the path of electrons.



The amount of deviation of the particle from their path in the presence of electrical or magnetic field depends upon:

i) the magnitude of the negative charge on the particle (greater the magnitude of the charge on the particle, greater is the deflection).

ii) the mass of the particle (lighter the particle, greater the deflection).

iii) the strength of the electrical or magnetic field (the deflection of electrons from its original path increases with the increase in the voltage across the electrodes, or the strength of the magnetic field).

In the absence of electric or magnetic field, the cathode rays hit the screen at point B. When only electric field is applied, the electrons deviate from their path and hit the cathode ray tube at point A. Similarly, when only magnetic field is applied, electrons strikes the cathode ray tube at point C. By carefully balancing the electrical and magnetic field strength, it is possible to bring back the electron beam to the point B. By carrying out accurate measurements, Thomson was able to determine the value of e/me as:

$$e/m_e = 1.758 \times 10^{11} \, C \, kg^{-1}$$

where me is the mass of the electron in kg and e is the magnitude of the charge on the electron in coulomb (C).

Charge on the Electron (e)

R.A. Millikan determined the charge on the electrons by a method known as 'oil drop experiment'. He found that the charge on the electron to be -1.6022×10^{-19} C.