e/m by HELICAL METHOD APPARATUS

OBJECT: To determine the value of e/m for an electron by Helical method.

APPARATUS:

The set of Experimental set up comprises of the following:

1. DC Power supply for apparatus comprises of the following built in parts:
   (a) H.T. (High Tension) DC power supply continuously variable from 375V to 850V±5% for acceleration voltage control.
   (b) DC Power supply for solenoid 0-60VDC variable in steps through two band switches (5 steps) using fine and coarse controls band switches.
   (c) Potentiometers are mounted on the front panel for Focus control, Intensity control and X, Y shift controls.
   (d) Two meters to measure acceleration voltage &solenoid current are mounted on the front panel.
   (e) Eight pin octal bases are mounted on the front panel to connect the CRT plug.
2. One long solenoid wound on 4″dia PVC with 23 wire gauge, mounted on wooden stand & connections brought out at terminals.
3. CRT mounted inside the solenoid.

THEORY:

Electronics emitted from the cathode, accelerated by the anode are deflected by the electric field to give a line on the fluorescent screen. The current carrying solenoid which encloses the Cathode Ray Tube provides the necessary magnetic field for focusing if alternating potential is applied to the plates then the electrons shall experience a transverse alternating force. Under the influence of this potential, we shall get a line on the Cathode Ray Tube screen. The length of the line shall depend on the strength of the applied potential. Now if the longitudinal field because of solenoid is applied, the electron describes a circular path. Motion of the electron in circular path is balanced by the centrifietal forces supplied by the magnetic field.

This is a popular method to find e/m. in this method, the cathode ray tube is placed inside a solenoid, if B is the magnetic field to make the spot then, and formula used to calculate the value of e/m is

$$B = (4p\ ml / 10L) \cos\theta$$

Where L is the Length of Solenoid

$$\mathbf{Cos\ \theta = L / (D^2 + L^2)^{1/2}}$$ (D is the Diameter of the Solenoid)

and $e/m = [5\times10^7 (L/nl \cos\theta)^2]\ V/l^2$ e.m.u. /g

Where L=length of X or Y plate
n= number of turns in the Solenoid.
I = Solenoid Current
V= Applied voltage (Acceleration Voltage)

PROCEDURE:

1. With the help of magnetic compass draw east- west line. Place the solenoid along E-W line and place the cathode ray tube inside the solenoid.
2. Connect CRT plug to the 8 pin base provided on the front panel of the power supply. Also connect DC for Solenoid to Solenoid terminals. Set the polarity of Dc for solenoid to +ve side by throwing the solenoid selector switch towards +ve side.
3. Switch ON the power supply & adjust the acceleration voltage to approx 600V. Also adjust the spot on the CRT using focus & intensity controls provided on the front panel. Keep X&Y plate deflection switch towards XP side & by using the X-shift deflection control pot, adjust the line to app. 1.5 to 2cms on CRT
4. Now apply the magnetic field by supplying current to the solenoid. Adjust the current in such a way that the line on the screen gets reduced to a point again. Note down the current of the power supply through current meter mounted on the front panel.
5. Reverse the current in the solenoid by changing the polarity of the solenoid power supply through DPDT switch provided on the front panel and adjust again to get a point on the screen. Note down the value of the current. Take the mean of the two values. Let the mean be "I".
6. Change the value of acceleration voltage to 650V and repeat steps 3-5.

7. Repeat steps 3-5 for another acceleration voltage.
8. Plot a graph between V andI^2 by taking voltage along X-axis &I^2 along Y axis, which will be a straight line. The slope of the line gives the value of (V/I^2)

OBSERVATIONS:

Constants of the Cathode Ray Tubes:

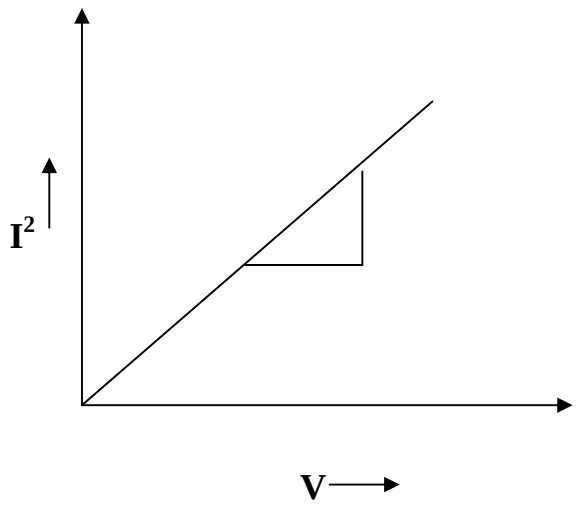
DESCRIPTION	CRT3BP1
(a) Separation between the plates (d)	10mm±1mm
(b) Length of plate (I)	25mm±1mm
(c) Distance of the screen from the edges Of the plates	130mm±1mm

OBSERVATION TABLE:

S.No.	**Acceleration Voltage (V)**	**Current Measured**			**V/I (V/A)**	**e/m (C/kg)**
		In I^{st} dir.	**In IInd dir.**	**Avg. Current**		

GRAPH:

Take V along X-axis and I^2 along Y axis, Take two points A and C and make a triangle ABC as shown in fig.



CALCULATIONS:

$$e/m = \frac{[5\times10^7 (D^2+L^2)]V}{n^2 L^2 I^2} I^2 \text{ e.m.u./gm}$$

Where

Length of the solenoid L= 50 cm

Number of turns per centimeter N =n =19 Turns/cm

Diameter of the solenoid

D=3.5 Inches=3.5 × 2.54 =8.9 cm

Length of plates (I) =10 mm

RESULT:-

Experimental value of e/m=…….

Standard value of e/m from the tables = 1.758×10^7 e.m.u. /gm

% error =……

PRECAUTIONS:-

1. The solenoid should be along E-W direction
2. The value of solenoid current and Acceleration voltage should be read carefully
3. The Cathode Ray tube should be placed symmetrically with in the solenoid