PHYSICS PRACTICAL SHEET

DETERMINATION OF SPECIFIC CHARGE OF ELECTRON (e/m) BY THOMSON'S METHOD

Apparatus Required:

i) Cathode ray tube
ii) Compass box
(ii) Pair of bar magnets.
(iv) Wooden stand.

Theory:

Figure (1) shows a cathode ray tube. It consists of three basic components: electron gun, deflecting system, fluorescent screen. The electron gun which produces, accelerates and focuses emitted electron into a narrow beam. The deflecting system which deflects the electron beam either electrically or magnetically. The beam of electrons impinges on the fluorescent screen to produce a visible spot.

We know, $\dfrac{e}{m} = \dfrac{y \times Y \times 10^7}{l L H^2 d}$ e.m.u./gm
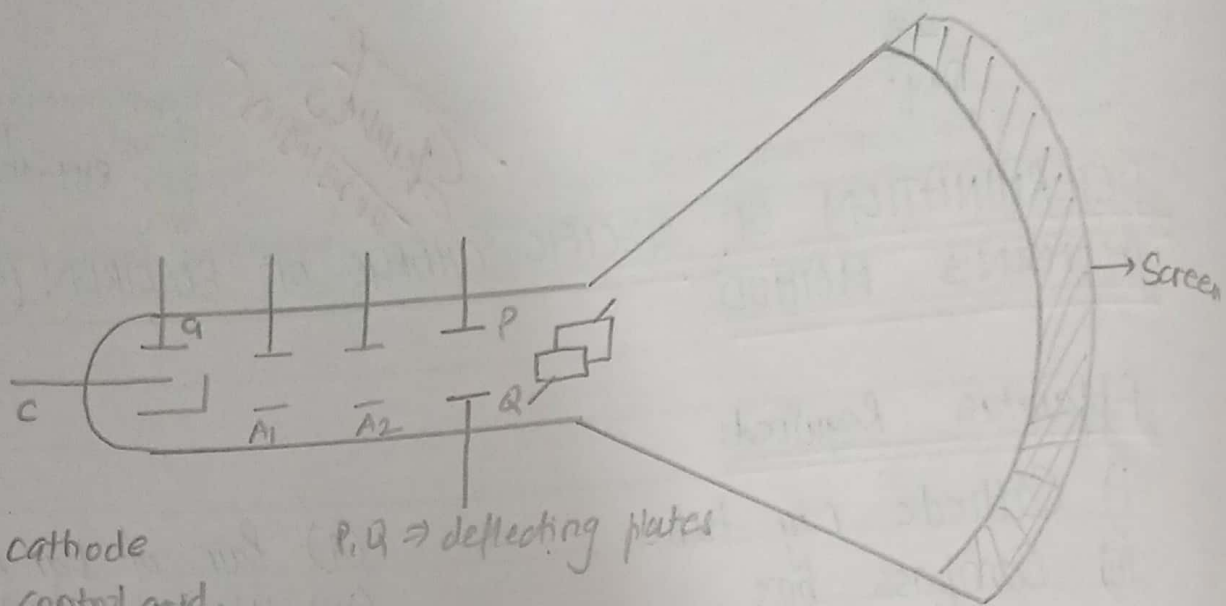
Here,

l = length of deflecting plates
L = distance of screen from edges of plates
y = total deflection of the spot on the screen
H = intensity of the applied field.
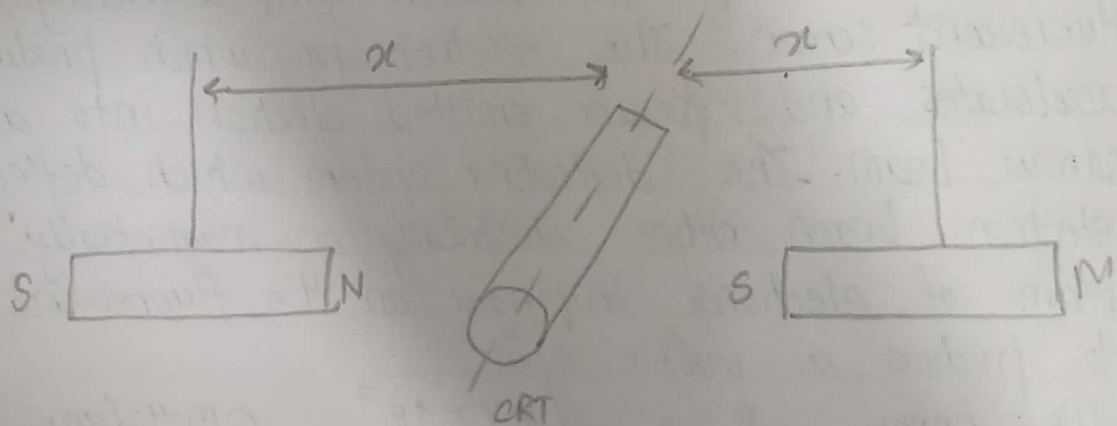d = separation between plates.

C = cathode   P, Q ⇒ deflecting plates

g = control grid

A_1 = first anode (focusing) A_2 = second anode (accelerating)

CRT

Observations:

distance between plates $(d) = 0.285$ cm
length of plates $(l) = 3.15$ cm
distance between screen & router $(L) = 12$ cm
Horizontal component of Earth's
magnetic field. $(H_e) = 0.35$

S.No	Magnet distance	θ	$\tan\theta$	$H = H_e \tan\theta$	V (Volts)	Y (cm)
1	11.5	30	0.577	0.202	2.7	0.30
2	9	40	0.839	0.294	3.8	0.40
3	6.5	45	1	0.35	4.8	0.45

Calculations:

$$\frac{e}{m} = \frac{V \times Y \times 10^7}{l L d H^2}$$

for $\theta = 30°$,

$$\frac{e}{m} = \frac{2.7 \times 0.30 \times 10^7}{3.15 \times 12 \times 0.285 \times 0.202} = 1.64 \times 10^7 \text{ emu/gm}$$

for $\theta = 40°$,

$$\frac{e}{m} = \frac{3.8 \times 0.40 \times 10^7}{3.15 \times 12 \times 0.285 \times 0.294} = 1.63 \times 10^7 \text{ emu/gm}$$

for $\theta = 50°$ $45°$,

$$\frac{e}{m} = \frac{4.8 \times 0.45 \times 10^7}{3.15 \times 12 \times 0.285 \times 0.35} = 1.64 \times 10^7 \text{ emu/gm}$$

RESULT :

The obtained value of e/m = 1.703×10^7 emu/gm

Standard value: 1.76×10^7 emu/gm

$\therefore$ % Error = $\left| \dfrac{1.703 \times 10^7 - 1.76 \times 10^7}{1.76 \times 10^7} \right| \times 100 \%.$

= 3.23%.

CONCLUSION

The specific charge of electron was calculated with 3.23% error.