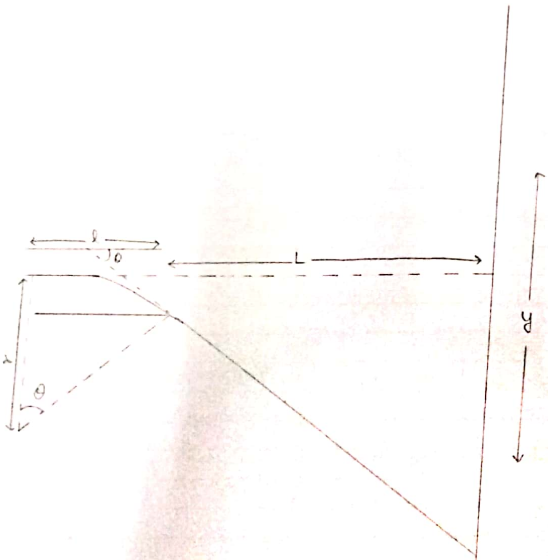

Determination of specific charge (e/m) of electron by J.J. Thompson's method.

THEORY : The ratio of charge to mass is known as specific charge. J.J. Thomson determined first the specific charge of the cathode ray which consists of -ve charged particles (electron), the cathode rays are produced by the application of high potential difference b/w cathode and anode in a high discharge tube kept at a low pressure. Inside tube b/w two metal plates a vertical electric field can be set up. By means of an external electromagnet a magnetic field can be established perpendicular to the electric field. If there is no magnetic field, the cathode ray stream will be deflected opposite to the direction of the electric field. The electric and magnetic field can be made to cancel each other by proper adjustment of electric and magnetic fields.

Let e and m be the charge & mass of electron and E and H are applied electric and magnetic field. If particle moves with vel v,

$$eE = Bev$$

$$\text{i.e } v = E/B$$

By applying magnetic field the electron beam will be deflected and the path describeds the arc of circle in magnetic field. If r be radius,

$$Bev = mv^2/r$$

On leaving the magnetic field at point C, it travels in straight line CD and hits the screen at the point D.

The deflection of the beam magnetic field

$$Y = (L + l/2) \cdot l/r$$

$$\text{i.e, } r = (L + l/2)\, l / y$$

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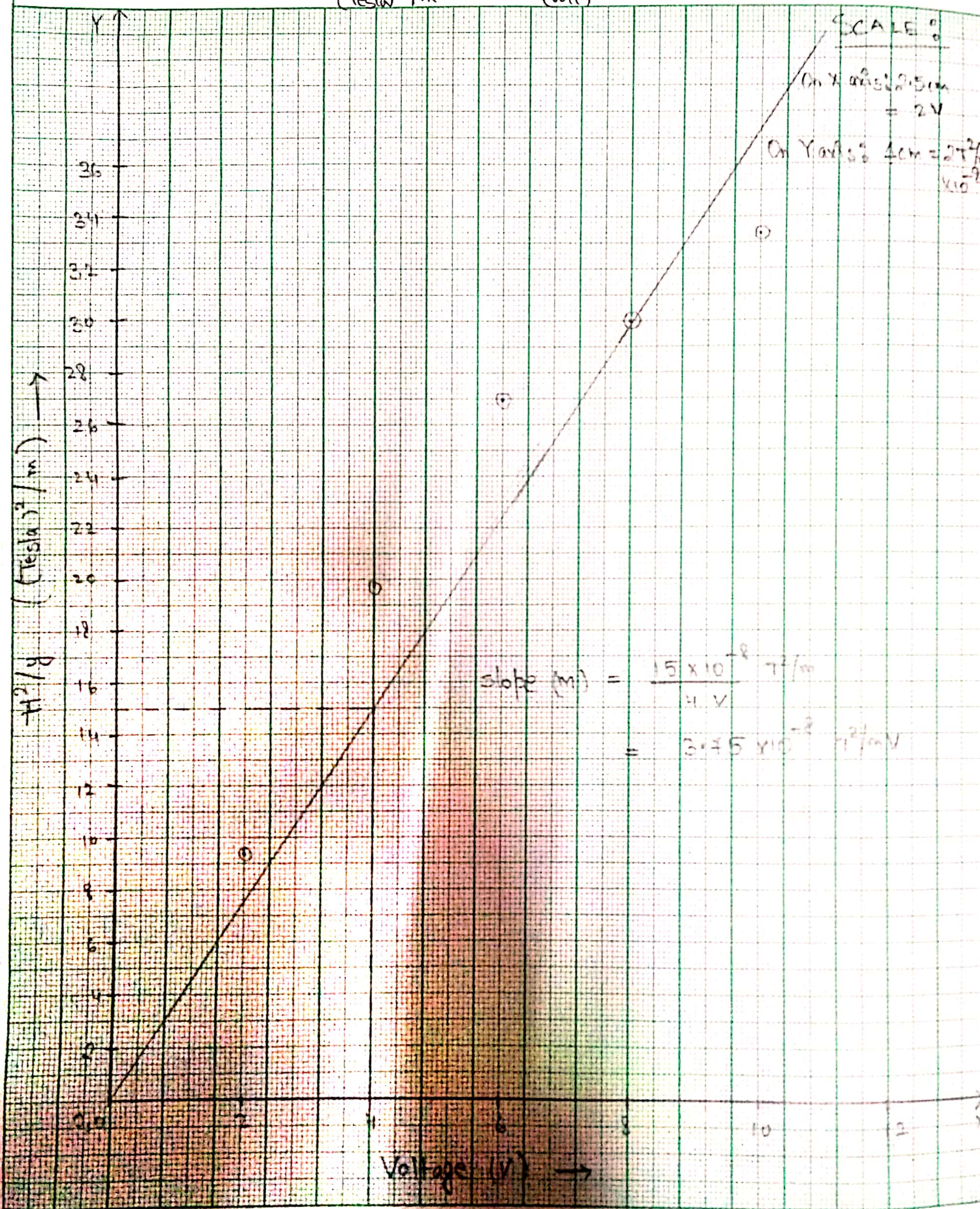
H^2/y ((Tesla)^2/m) Vs V (volt) Graph



$v = Ber/m = V/dB$

$e/m = V/(dH^2 r) = Vy/[d B^2 (L + l/2) l]$

for c.g.s s/m $B = H$ ∴

$e/m = Vy/[d H^2 (L + l/2) l]$ where V = applied voltage;
d = separation b/w plates;
H = intensity of field; y = total deflection of spot on screen
L = distance of screen from edge P and Q; l = length of plate
$H = H_e \tan\theta$ where H_e = earth's magnetic field

OBSERVATION TABLE:

$d = 0.04$ m ; $l = 0.025$ m ; $L = 0.14$ m ; $H_e = 3.45 \times 10^{-5}$ T

SL. No.	Voltage applied (V)	Deflection y (m)	Position of electron spot	R_1 (m)	R_2 (m)	Deflection Angle θ (deg)	Magnetic field H (T)	e/m ×10^{11}	Mean e/m ×10^{11}
1	0	0							
2	2	0.003	0.3	0.205	0.205	26	1.68×10^{-5}	1.39	
3	4	0.006	0.6	0.172	0.172	45	3.45×10^{-5}	1.32	
									1.58
4	6	0.009	0.9	0.150	0.150	55	4.93×10^{-5}	1.46	
5	8	0.012	1.2	0.133	0.133	60	5.98×10^{-5}	1.76	
6	10	0.015	1.5	0.125	0.125	64	7.07×10^{-5}	1.96	

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Date 31/01/2019

GRAPH : H^2/y Vs Voltage graph.

Voltage (V)	H^2/y $\times 10^{-8}$ T^2/m
2	9.468
4	19.8375
6	27.00
8	29.80
10	33.32

CALCULATION : From graph taking non experimental point (4, 15) we get slope(m) = 3.75×10^{-8} T^2/mV

$$\therefore e/m = \frac{Vy}{H^2} \times \frac{1}{dl(L+l/2)}$$

$$= \frac{1}{slope} \times \frac{1}{dl(L+l/2)}$$

$$= 2.66 \times 10^7 \times 6.557 \times 10^3$$

$$= 1.748 \times 10^{11} = 1.75 \times 10^{11}$$

DISCUSSIONS :

1. The axis of CRT is adjusted strictly along the magnetic meridian.
2. The oscillations of the magnetometer needle should be of small amplitude.
3. The bar magnets should be kept away during measurement of deflection spot.
4. The spot of the screen is adjusted to min visible brightness level.
5. Care should be taken to see that no magnetic material is in the immediate vicinity.

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