Lab 11: Electron Acceleration and Deflection by Electrostatic Fields

Philip Kim

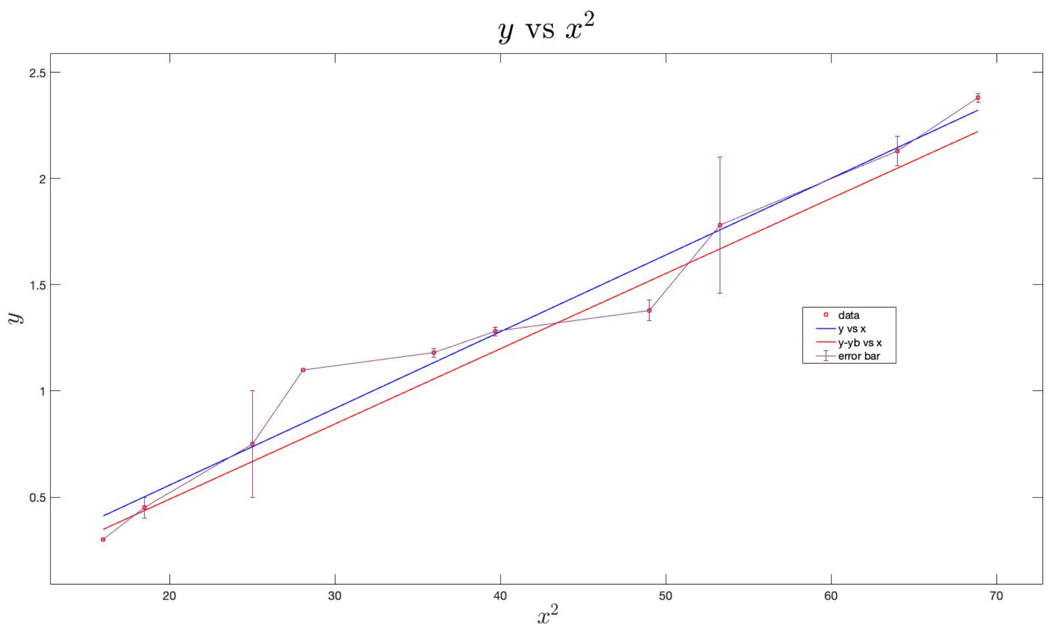
May 17, 2021

Table 2: Electron Deflection

X_{obs}	Y_{obs}	Y	F_D
8.3	-2.40, 2.35	2.38	0.025
8.0	-2.20, 2.05	2.13	0.075
7.3	-2.10, 1.45	1.78	0.325
7.0	-1.40, 1.35	1.38	0.050
6.3	-1.30, 1.25	1.28	0.025
6.0	-1.20, 1.15	1.18	0.025
5.3	-1.10, 1.10	1.10	0.000
5.0	-0.50, 1.00	0.75	0.250
4.3	-0.40, 0.50	0.45	0.050
4.0	-0.30, 0.30	0.30	0.000

(a) Measure the distance between the plates s = $\boxed{5.3\ cm}$

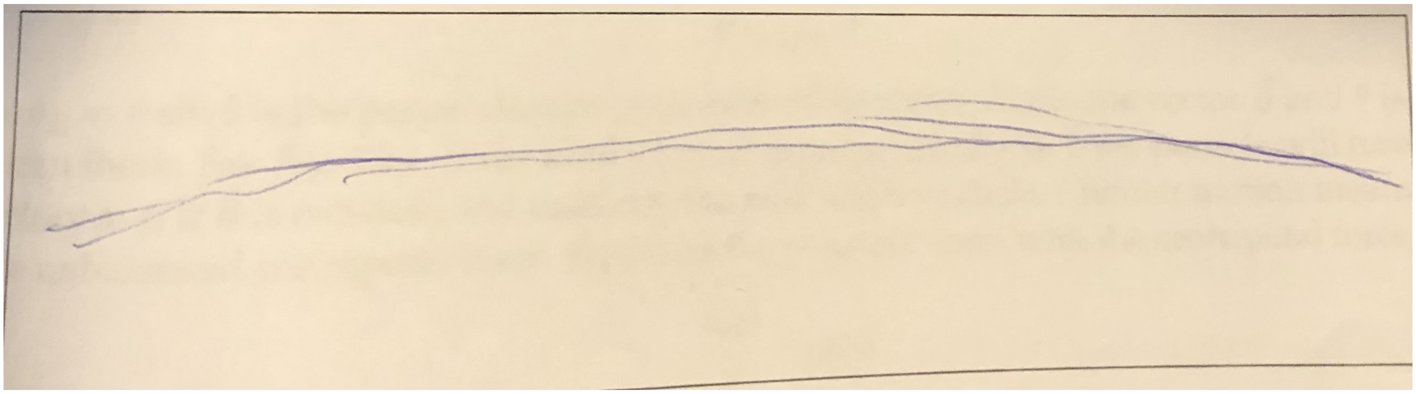
(b) Graph y $vs.$ x^2, include error bars. Measure the slope of the graph, slope = $\boxed{0.0326}$



(c) From the slope, calculate the correction factor F_D = $\boxed{0.687}$

Table 3: Thompson's Experiment				
$V_{PS}(kV)$	2.00	2.50	3.00	3.50
I (A)	0.18	0.23	0.28	0.33
B (T)	7.62e-4	9.73e-4	0.12e-2	0.14e-2
e/m (C/kg)	2.89e8	2.22e8	1.75e8	1.50e8

Sketch the path of the beam:



11.6 Questions

1. Calculate the speed of the electron for the maximum voltage available for acceleration, in meters per seconds.
$v = \sqrt{\frac{2qV}{m}} \rightarrow \sqrt{\frac{2\cdot(1.6\times10^{-19}\times10^{3})\cdot(3.5)}{9.1\times10^{-31}}} = \boxed{3.51\times10^{7}\ m/s}$

2. What fraction of the speed of light is this?
$\frac{v}{c} = \frac{3.51\times10^{7}}{3\times10^{-8}} = \boxed{0.117}$

3. According to the special theory of relativity, the mass m of an object that is moving with velocity v with respect to an observer is larger than its rest mass m_0. The rest mass is the mass of the object when it is at rest. The equation that describes this phenomenon is

$$m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}},$$

where $c = 3.0\times10^{8} m/s$ is the speed of light in vacuum. Evaluate the mass for the electrons in this experiment that are moving at v you calculated in 1. How much larger is this than m_0?
$m = \frac{9.1\times10^{-31}}{\sqrt{1-\frac{(3.51\times10^{7})^2}{(3\times10^{-8})^2}}} = \boxed{9.1629\times10^{-31}kg}$ $\quad \frac{m}{m_0} \rightarrow \frac{9.1629\times10^{-31}}{9.1\times10^{-31}} = 1.0069 \rightarrow \boxed{0.69\%\ larger\ than\ m_0}$

4. Compare your measured e/m from Thompsons Experiment to the known value, $1.76\times10^{11}C/kg$.
$\frac{e}{m} = \frac{1.6\times10^{-19}}{9.1629\times10^{-31}} = \boxed{1.747\times10^{11}\ C/kg}$