

PHYS 102 Experiment 3. Charged Particle in an Electric Field

Preliminary work:

Force on a particle with charge q in an electric field \vec{E} is $\vec{F}=q\vec{E}$. By Newton's second law, particle's acceleration due to this force will be $\vec{a}=(q/m)\vec{E}$. We consider a particle shot horizontally into a region with velocity $\vec{v}=v_{0x}\hat{i}$ where a uniform electric field \vec{E} exists in the vertically upward direction. Taking the point where the particle enters the region as the origin, (horizontal) and (vertical) components of its position at any time will be given by the kinematic equations and Eliminating between these two equations we get the equation for the trajectory of the particle as $y=(q/2m)E(x/v_{0x})^2$.

Online Experiment Link:

<https://ophysics.com/>

Procedure:

1. Open the website given under the "Online Experiment Link". From the top menu choose the menu item "E&M", and from the appearing drop-down menu choose the experiment "Charged Particle in an Electric Field".

2. Read the description given at the bottom of the page.

3. Set the following values for the parameters:

Voltage $V=+3V$,

Distance Between Plates $d=4cm$,

Charge of Particle $q=1\mu C$,

Particle Mass $m=0.3\times 10^{-16}kg$

In this case, the y -component of the point where the particle hits the top plate will be $y=0.02m$, and the equation of the trajectory will be written as $(q/2m)E(x/v_{0x})^2=0.02$.

4. Run the simulation for different values of the initial velocity and complete the table below by roughly estimating the x -position (horizontal distance from the beginning of the plate) of the point where the particle hits the top plate.

| $v_{0x}(10^5 m/s)$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|--------------------|---|---|---|---|---|---|---|---|
| $x(m)$ | | | | | | | | |

5. Plot v_{0x} (on the vertical axis) versus x (on the horizontal axis) on a graph paper. You should have a straight line.

6. Measure the slope of the straight line from the plot.

7. Use the value of the slope you found to calculate the ratio of the particle, and compare it with the value given in the simulation.

8. Write a properly formatted report of your results, convert it into a PDF file and upload it to MOODLE. Deadline for submission is Monday, 27 July 2020 at 07:59 (am). Late submissions will result in deduction of 10 points for each day late.