Department of Mathematics and Natural Sciences

Physics -112 Lab Assignment: 01

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Section : 02

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Resources:

Link for online lab:

https://phet.colorado.edu/sims/html/coulombs-law/latest/coulombs-law_all.html

List and link for the graph-plotting softwares:

- Desmos (Online): Desmos | Let's learn together.
- Graph (Offline): Download | Graph (padowan.dk)

Tutorials:

- Tutorial link for plotting in Desmos :

https://www.youtube.com/watch?v=-lIUNWVKnUY

- Tutorials link for the Graph :

How to install graph software:

https://youtu.be/e19JqLJMx3A

How to draw a curve using graph software:

https://youtu.be/QBkdzU_8vVo

How to calculate the slope of a line using graph software:

https://youtu.be/z4cMiUFu5j8

Tasks:

This activity consists of two Parts:

1. Part one: Eclectic force versus distance.
2. Part two: Electric forces versus charge.

Objectives:

1. Satisfy Coulomb's law experimentally
2. Study the parameters that affect the electric force (distance and charge).
3. Find experimentally the electric constant k.

Theoretical Background:

Coulomb's Law: "The magnitude of the electric force that a particle exerts on another is directly proportional to the product of their charges and inversely proportional to the square of the distance between them." Mathematically, the magnitude of this electrostatic force F_E acting on two charged particles (q_1, q_2) is expressed as:

$$F_E = kq_1q_2/r^2$$

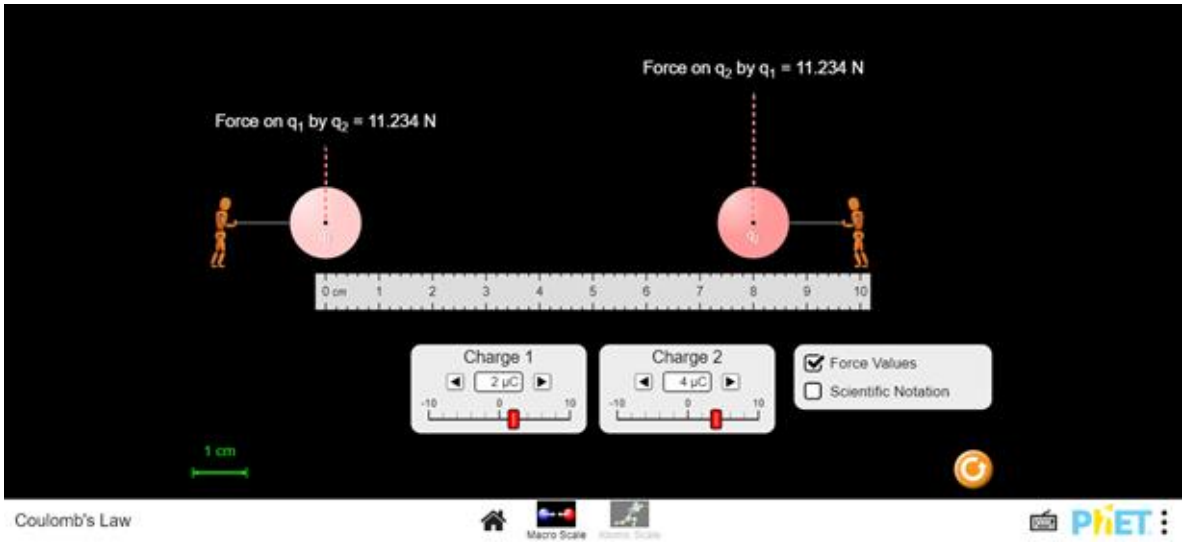
Where r is the separation distance between the charged objects and k is a constant of proportionality, called the Coulomb constant, $k = 9.0 \times 10^9$ Nm^2/C^2.

Part one:

To satisfy the objectives do the following steps.

1. Click on the following link and fix the charge q_1 and q_2 write their values in table.1.

https://phet.colorado.edu/sims/html/coulombs-law/latest/coulombs-law_en.html



2. Change the distance between the two charges as shown in the table.
3. Record the force value for each distance.
4. Fill table 1 by finding r^2 and $1/r^2$.

Table.1 : Data of Force between two charges.

q_1=...2µC.....		q_2= 4µC	
r (cm)	**r^2 (m^2)**	**$1/r^2$ ($1/m^2$)**	**F_E (N)**
10	0.01	100	7.2
9	0.0081	123.46	8.88
8	0.0064	156.25	11.25
7	0.0049	204.08	14.69
6	0.0036	277.77	20
5	0.0025	400	28.8
4	0.0016	625	45
3	0.0009	1111.11	80

Part two:

To satisfy the objectives do the following steps.

1. Click on the following link and fix the charge q_1 and the distance r, write their values in the table https://phet.colorado.edu/sims/html/coulombs-law/latest/coulombs-law_en.html
2. Control q_1 and fix it at 5mc and fix the distance between the two objects at 6 cm, record them in table 2.
3. Change the charge of object 2 as shown in table.2 and for each q_2 record the electric force between the two objects in table 2.

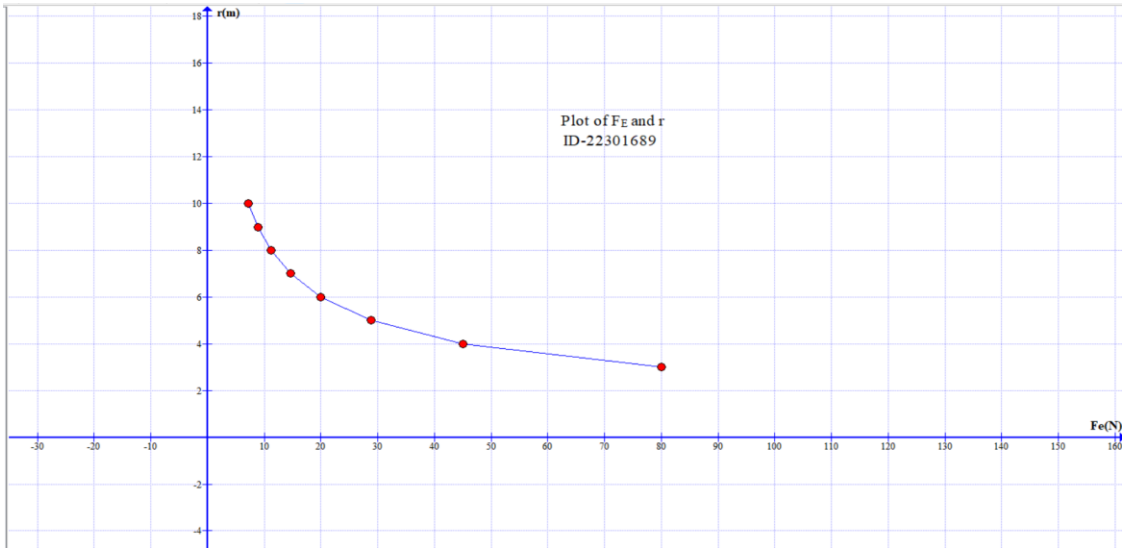
Table.2 : Data for electric force for different charges.

q_1 = 5 μC	**r = 6 cm**
q_2 (μC)	F_E (N)
10	125
9	112.5
8	100
7	87.5
6	75
5	62.5
4	50
3	37.5

Calculations and Analysis:

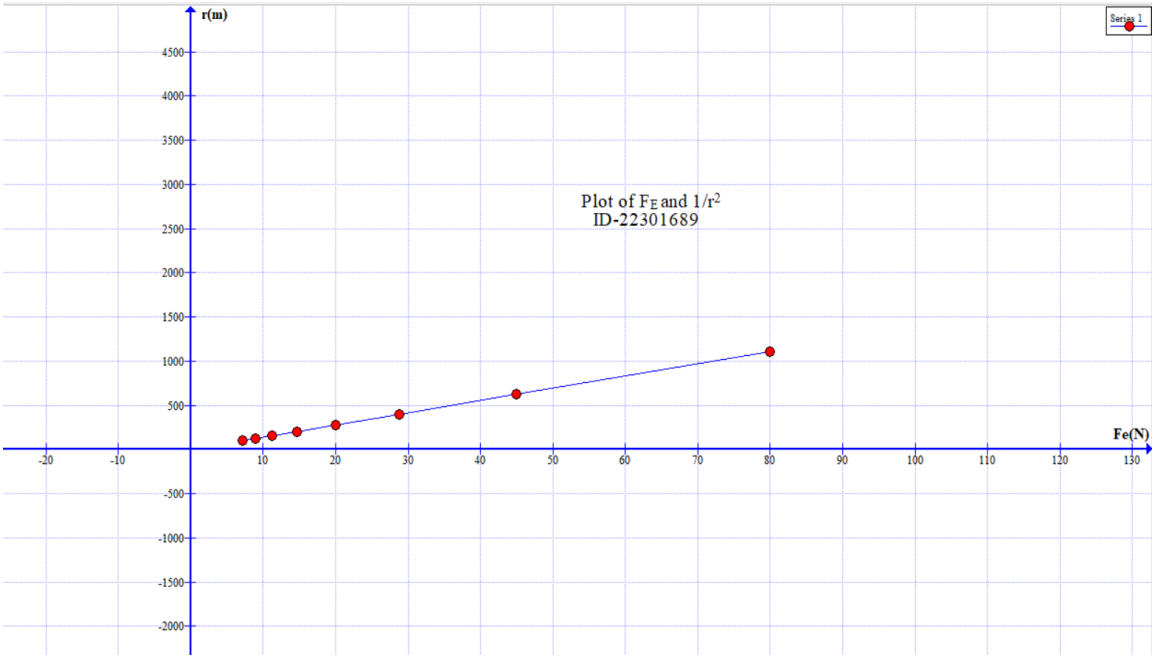
Part one:

1. Plot a graph relating F_E and r. comment on the graph.



This graph illustrates how the force(F_E) applied to charge changes with the distance(r) . If the force increases directly with the distance, like in a spring, the graph will show a straight line going up. On the other hand, if the force decreases as the distance increases, with gravity, the graph will start high and curve downwards.

2. Plot one more graph relating F_E and $1/r^2$. Use the graph to find the electric constant k.



If we choose two pints from the F vs $1/r^2$ graph,

X_1=20.1 , Y_1 =224,

X_2 =69.9 , Y_2 = 759

Hence, gradient = $(X_2-X_1)/(Y_2-Y_1)$

= 14.69

So, the electric constant k is 14.69 N.

3. Calculate the percentage error in k (k_{known}=9.0 × 10^9 Nm^2/C^2)

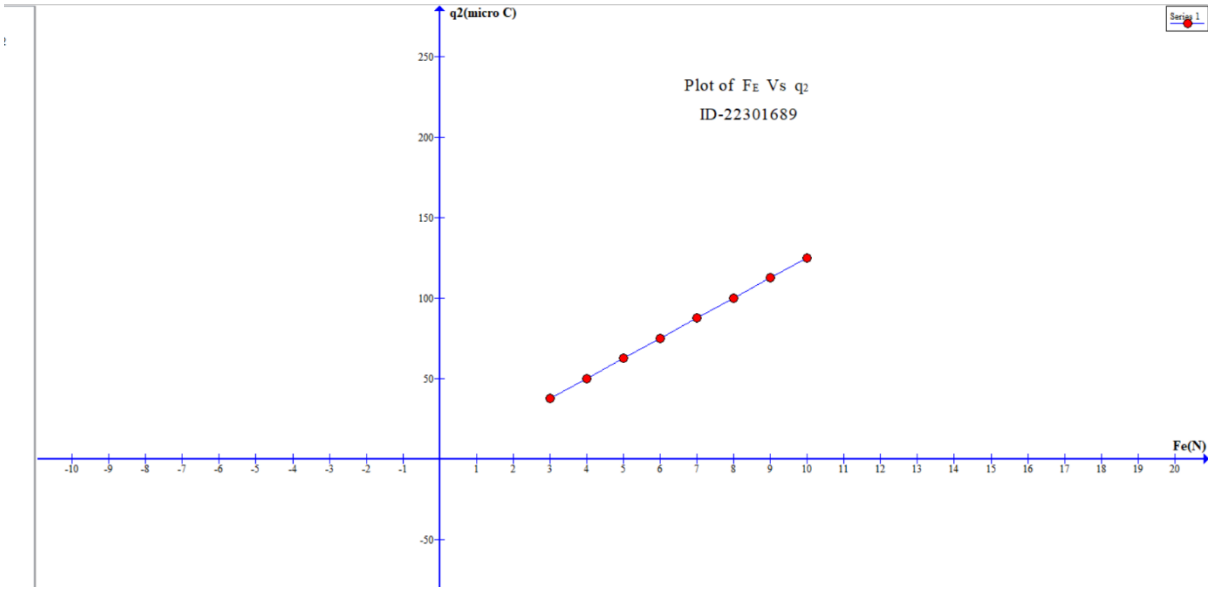
The percentage error in k = $(14.69- 9.0\times10^9)/ 9.0\times10^9 \times100$

= 99.99 %

Note: upload graph using google form

Part two:

1. Plot a graph relating F_E and q_2. comments on the graph.



The graph of Force (F) versus Charge (Q) provides a visual representation of Coulomb's Law. In this graph, as the force should increase proportionally with the charge. The slope of the line represents the constant of proportionality.

2. Use the graph to find the electric constant k.

For determining the Electric Constant K,
Lets choose two points from the slope of the graph :

X1=5, Y1=60
X2=7, Y2=80

Hence, gradient = $(X_2-X_1)/(Y_2-Y_1)$

m =0.1

Now,
According to Coulombs Law,
if q_1 and r fixed or constant , the slope(m) is equivalent is to :
$K= m*r^2/q_1$

So ,k= 72 N [r=0.06 m ; q1= $5x10^{-6}$ μC]

3. Calculate the percentage error in k ($k_{known}=9.0 \times 10^9$ Nm^2/C^2)

The percentage error in k = $(72- 9.0\times10^9)/ 9.0\times10^9 \times100$
= 99.99 %

Note: upload graph using google form