PH170-LAB3

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STD ID:202151188 SECTION:2C

MEASUREMENT OF ELEMENTARY CHARGE USING MILLIKAN OIL DROP

Theory:

This simulation is a simplified version of an experiment done by Robert Milliken in the early 1900s. Hoping to learn more about charge, Milliken sprayed slightly ionized oil droplets into an electric field and made observations of the droplets. When the voltage is zero and the run button is pressed, the drop will fall due to the force of gravity. It will reach a terminal velocity (v_t) as it falls. Pause the simulation while you record the terminal velocity. This terminal velocity can be used to determine the mass of the drop. Use the equation: mass = kv_t^2 to determine the mass of the particle. The value of k in this simulation is 4.086×10^{-17} kg s^2/m^2. Once the terminal velocity is recorded and the mass calculated, with the simulation still paused increase the voltage between the plates until the two force vectors are approximately equal length. This will produce an upward field and an upward force on the positive droplets. If the upward force of the electric field is equal to the downward force of gravity, and the drag force is zero, the particle will not accelerate. To be sure that the lack of acceleration is not related to drag forces, the velocity must also be zero as well as the acceleration in order to be sure that the two forces are balanced. Increase and decrease the voltage (use the left/right arrow keys) until both the acceleration and velocity are at zero. The velocity may not stay at exactly zero, but find the voltage that has the velocity changing most slowly as it passes v = 0.

Parameters:

$m = kv_t^2$

$k = 4.086 \times 10^{-17}\ kgs^2 / m^2$

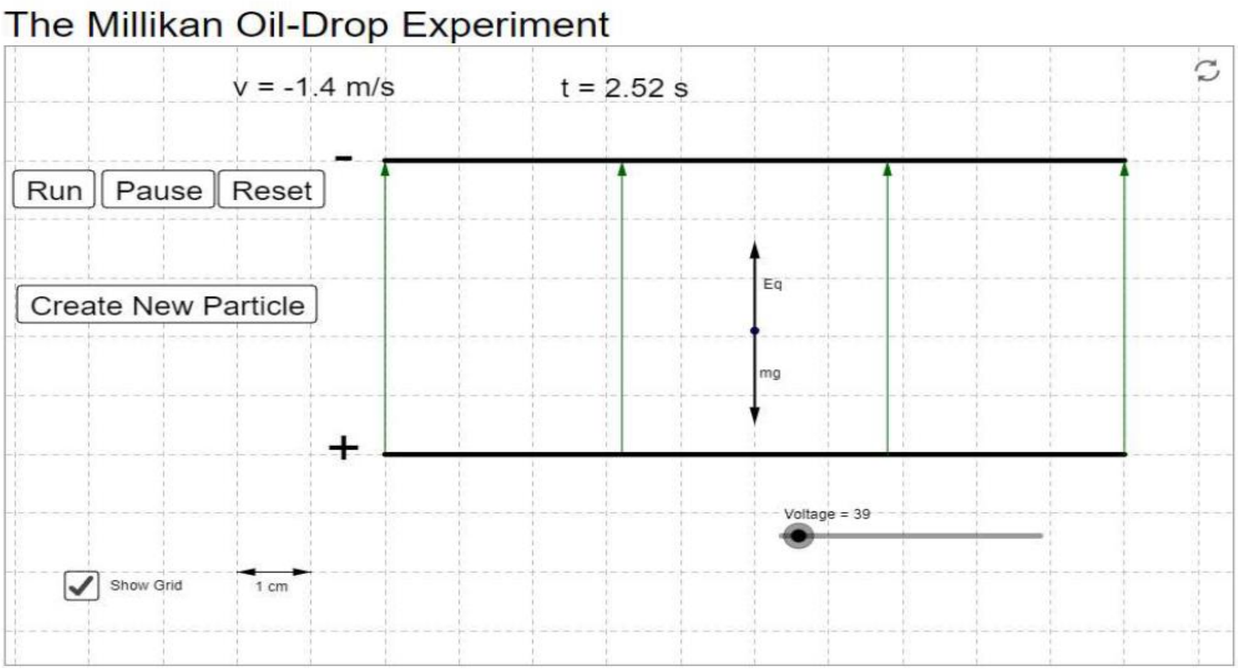
$V=Ed$ (d=5cm)

$E_q = mg$

V = voltage across the plate

E = field strength

d = distance between the plates



Observation table:

Vt(m/s)	Mass(*10^-17)	voltage V	distance m	electric field,E	Charge(*10^-19)	n(Q/e)
-1.4	8.008	39	.05	780	9.61	6.01
-1.072	4.695	26.3	.05	526	8.24	5.15
-1.067	4.652	23.8	.05	476	9.57	5.99
-1.079	4.757	31.3	.05	626	7.44	4.12
-1.352	7.468	57.5	.05	1150	6.36	3.98
-1.48	8.94	67.9	.05	1358	6.45	4.03
-1.419	8.22	63.4	.05	1268	.6.31	3.99
-1.036	4.385	21.2	.05	424	10.9	6.98
-1.007	4.143	14.7	.05	294	13.1	8.16
-1.128	5.198	34.8	.05	696	7.96	4.97

Error Analysis:

In the experiment conducted above, there had been minute errors while taking values for calculation. Due to this there was deviation in value of n which is listed below: (d=deviation)

Sr. no	Q(10^-19)(C)	d=q-ne(in 10-19)
1	9.61	.01
2	8.24	.15
3	9.57	.01
4	7.44	.12
5	6.36	.02
6	6.45	.03
7	6.39	.01
8	10.9	.02
9	13.1	.16
10	7.96	.03

PART-2: RELATE THE ELECTROSTATIC FORCE MAGNITUDE TO THE CHARGES AND THE DISTANCE BETWEEN THEM

Theory:

Coulombs Law: According to Coulomb's law, the force of attraction or repulsion between two charged bodies is directly proportional to the product of their charges and inversely proportional to the square of the distance between them. It acts along the line joining the two charges considered to be point charges.

$$F = k\frac{q_1 q_2}{r^2}$$

F = electric force
k = Coulomb constant
q_1 , q_2 = charges
r = distance of separation

Properties:

1. Like charges repel each other, and unlike charges attract each other. Here the two charges are namely positive and negative.
2. The attraction and repulsion acts along the line between the two charges.
3. The size of force varies inversely as the square of the distance between the two charges.

Observation table:

Table 1: q1=fixed; r=fixed; q2=varying

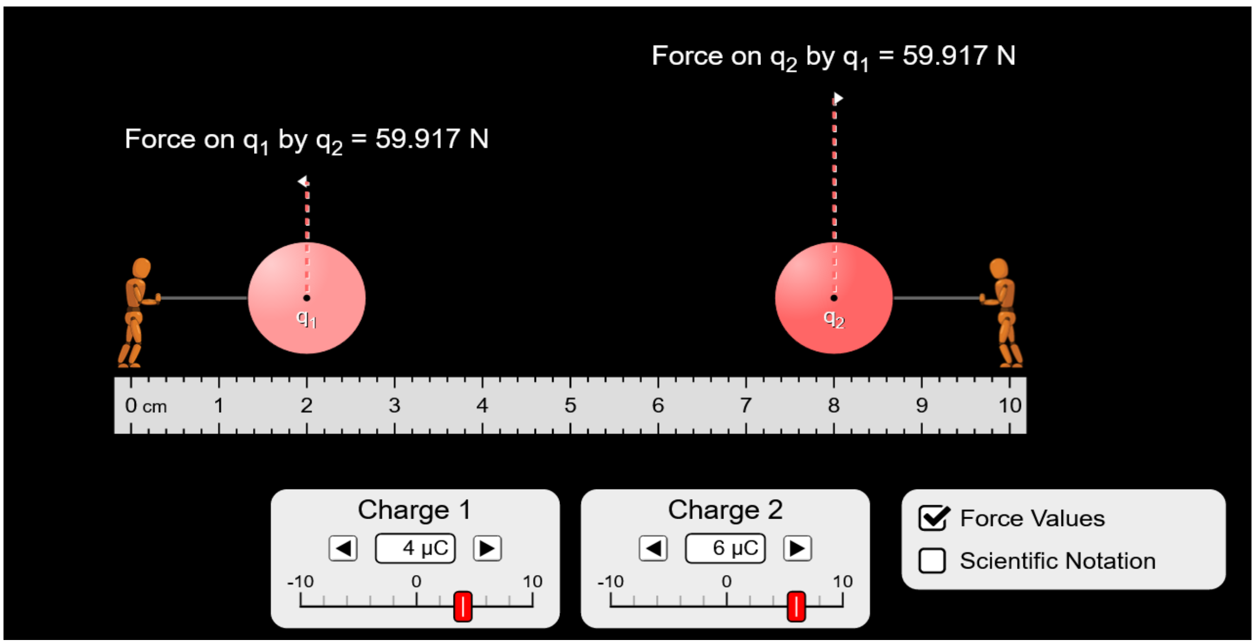
Sr. no	r(m)	q1(uC)	q2(uC)	F(N)	K(*10^8)
1	0.04	-3	1	29.95	89.8
2	0.04	-3	2	59.92	89.78
3	0.04	-3	5	149.79	89.76
4	0.04	-3	4	119.83	89.8
5	0.04	-3	6	179.75	89.8

Table 2: q2=fixed; r=fixed; q1=varying

Sr. no	r(m)	q1(uC)	q2(uC)	F	K(*10^8)
1	0.04	-3	4	119.83	89.7
2	0.04	-2	4	79.89	89.8
3	0.04	5	4	199.72	89.76
4	0.04	7	4	279.61	89.77
5	0.04	-6	4	239.67	89.82

Table 3: q1=fixed; q2=fixed; r=varying

Sr. no	r(m)	q1(uC)	q2(uC)	F	K(*10^8)
1	0.02	4	6	539.25	89.8
2	0.03	4	6	256.48	89.73
3	0.05	4	6	86.28	89.7
4	0.04	4	6	134.81	89.78
5	0.06	4	6	59.91	89.81



Inference:

The value of K remains almost constant even if we keep varying charge or distance.