

RUTGERS UNIVERSITY

PHYSICS 2 LAB

ElectroStatics 2

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SIGNATURES

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Part 1 - Amount of Charge

procedure and goal

We applied varying voltage sources to a spherical capacitor. We then measured the charge on the spherical capacitor. Our goal was to find the relationship between the voltage applied and charge measured.

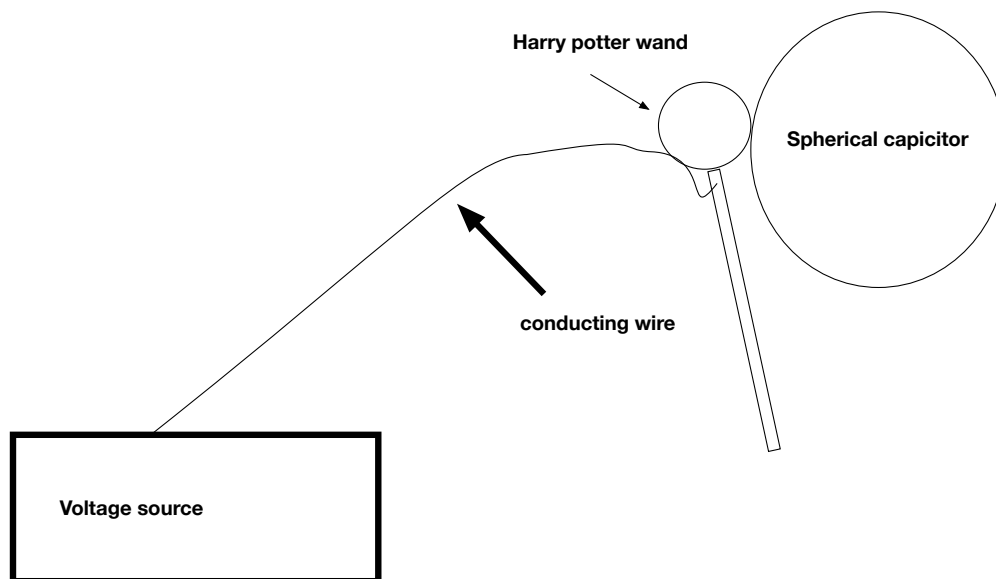


Figure 1: the setup to get current to the sphere

The Harry Potter wand is just there to transfer current to the sphere. It is not necessary but it is safer for students; we could have connected the voltage source straight to the sphere.

Prediction

From our knowledge of physics we know that charge travels from high potential to low potential. The *voltage source* always has a fixed potential, while the Sphere has zero potential. But after the connection from the voltage source to the sphere is made, charge travels from the voltage source to the sphere until the sphere's potential equals the voltage source's. Because we know the capacitance and final potential of the sphere, we can calculate the

amount of charge on the sphere Using the the formula $C = \frac{Q}{V}$

$$C = 4\pi\epsilon_0 R = 4\pi * 8.85 * 10^{-12} * .045 = 5 * 10^{-12} \quad (1)$$

$$Q = V * C = \mathbf{750} * 5 * 10^{-12} = 3.75 \text{ nC} \quad (2)$$

$$Q = V * C = \mathbf{1500} * 5 * 10^{-12} = 7.5 \text{ nC} \quad (3)$$

$$Q = V * C = \mathbf{3000} * 5 * 10^{-12} = 15 \text{ nC} \quad (4)$$

$$Q = V * C = \mathbf{6000} * 5 * 10^{-12} = 30 \text{ nC} \quad (5)$$

making a table we get

voltage(v)	charge(nC)
750	3.75
1500	7.5
3000	15
6000	30

Results

Here are our results. The charge values here are the peak charged observed:

voltage(v)	charge-predicted(nC)	charge-observed(nC)
750	3.75	1.9
1500	7.5	2.9
3000	15	4.1
6000	30	5.8

Analysis

The measured charge was a lot lower than the predicted. Here are possible explanations

1. We did not hold the connection from the battery to the sphere long enough. Capacitors take time to charge up. We held it for about 2 seconds. Not sure if that is long enough?
2. Charge was lost to the Air. Electrostatic studies are difficult in humid environments because objects discharge quickly through multiple paths
3. We did not calculate the capacitance correctly. We calculated the capacitance to be $5 * 10^{-12}$ When we measured the radius the error was probably $\pm .02 \text{ meters}$, which is quite a lot in our experiment.

The predicted results are a perfect linear relationship, but the observed results seem to form a logarithmic relationship between voltage and charge. The best fit curve was $Q = 1.86 * \log(V) - 10.58$. We tried linear and polynomial models as well but the logarithmic had the lowest error. That is very interesting. Perhaps the air finds it easier to absorb high levels of charge? The only sure conclusion we can make is more voltage \rightarrow more charge.

Figure 2: A graph of our observed data vs predicted data

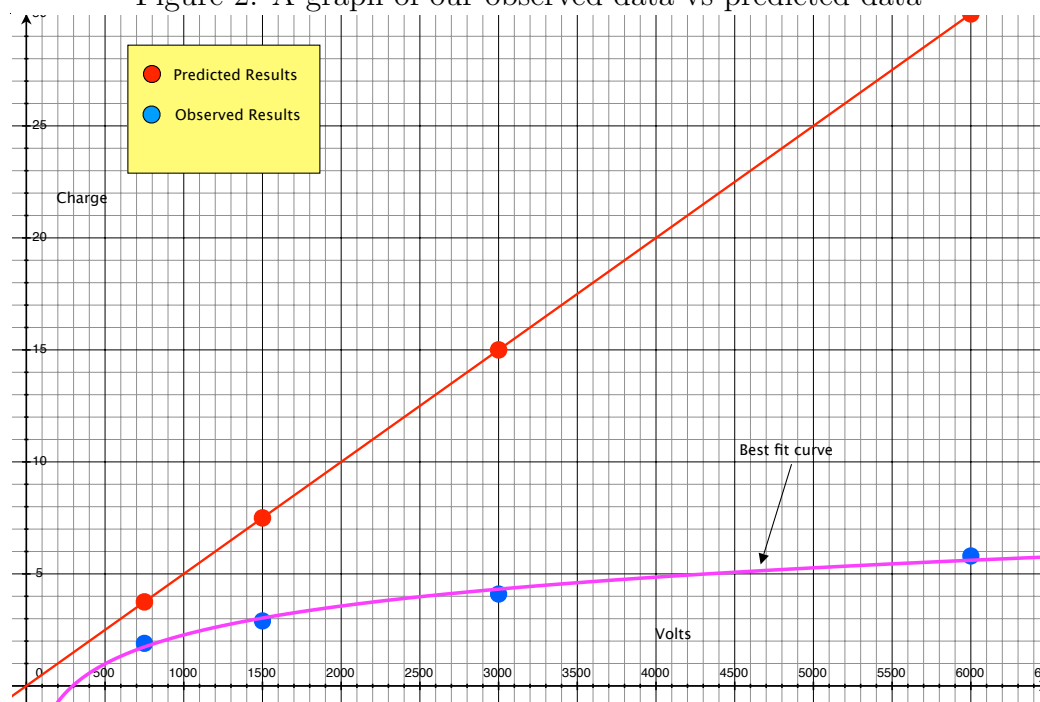


Figure 3: The best fit of curve was $Q = 1.86 * \log(V) - 10.58$

Part 2 - Distribution of charge

procedure and goal

After we we "charged" the conducting sphere, we collected charge from different parts of the sphere. Our goal was to see if charge in one part of the sphere was different than other parts of the sphere.

prediction

We predicted that the charge would be the same on every part of the sphere. At first the only place with charge would be the area where the Harry Potter wand touched the sphere, but since the other parts of the sphere have lower potential, the charge from the touched part would travel to the other parts of the sphere. Eventually the charge would balance itself out.

Results

Unfortunately we have no data, it was lost in transaction.

Part 4 - Charge By Induction

procedure and goal

We charged one sphere then brought that sphere close to the second sphere. Then we grounded the second. We measured charge on both spheres. Our goal was to see if we could get negative charge on one sphere.

Prediction

We predicted absolutely nothing would happen. One sphere will have the same charge from part 1. Bringing the two spheres close together does nothing because there is no conducting path for charge to travel. Grounded the second sphere will set the charge on the second sphere to zero, but it was already zero to begin with.

Results and analysis

Our Prediction was correct. The Grounded sphere had close to zero charge because all the charge was transferred to the body, while the charged sphere was close to 2.9 nC, which was expected for 1500 volts setting. Must have misinterpreted the instructions.