Electrostatics

Name:

PES 216 Report

Lab Station:

Objective *(up to you this time)*

The purpose of this lab was to investigate the nature of electric charge: how different materials obtain different charges, how like and opposite charges react with one another, how to inductively create charge with another charged object, and how well object retain their charge (insulator properties).

Data and Calculations

Part A: Charge Production

- Fill in the table with the Electrometer values (include the polarity +/-) for each rod vs. cloth pair. Use (+/-) MAX when necessary.

We rubbed different types of rod materials with different types of cloth in order to determine the static charges accumulated on the rods.

		Cloth Material Type		
		Wool	**Silk**	**Fur**
Rod Material Type	**Acrylic**	+ MAX	+ MAX	+ MAX
	Glass	+ MAX	+ MAX	+ MAX
	PVC	– MAX	– MAX	– MAX

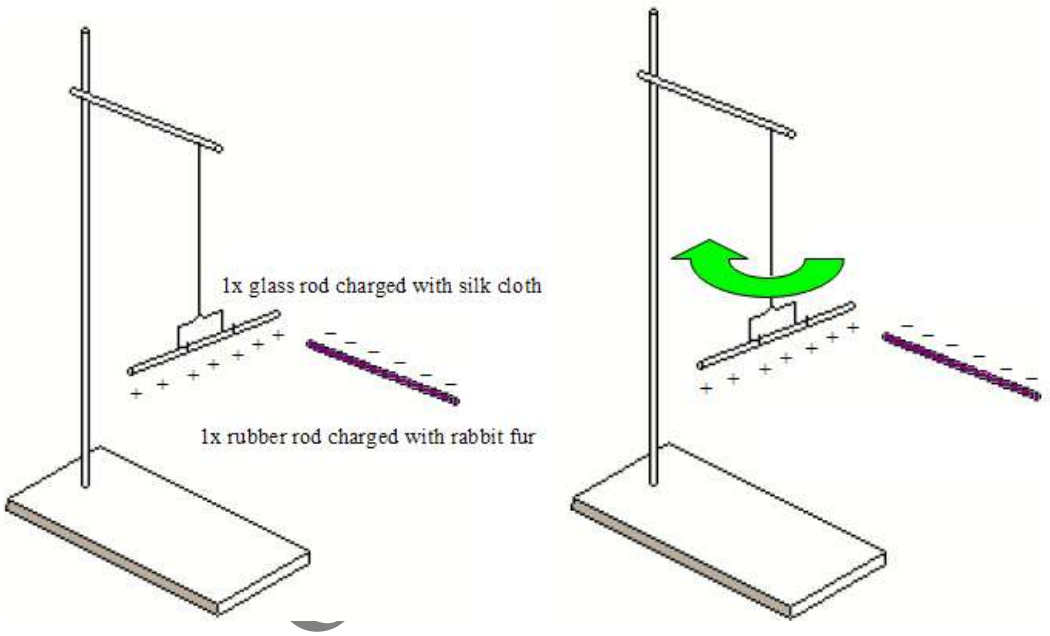
Between each measurement we grounded the rods back to an electrically neutral state (i.e., there was no net charge on the rod) before re-charging it with another cloth material type). We found that sometimes (especially for the PVC and the Acrylic rods) the charge on the rod was hard to completely remove. This was due to the fact that there was a hollow section though the middle of these rods, and since charge resides on the surface of an object, there was residual charge located along the inside of the Acrylic and PVC rods. Since the intent of this section was not magnitude of charge, but rather polarity – residual charge didn't have a major impact on the completion of this part of the lab.

Part B: Do opposites Really attract?

- How do oppositely charged rods react to each other?

For this part of the lab we used the glass rod charged using the silk cloth (since this was the most positively charged rod) and the PVC rod charged using the fur (since this was the most negatively charged rod).

We suspended the positively charged glass rod from a string and waited for it to come to complete equilibrium (i.e., no rotation/movement). We slowly brought the negatively charged PVC rod near the end of the positively charged glass rod and the glass rod end moved toward the PVC rod.



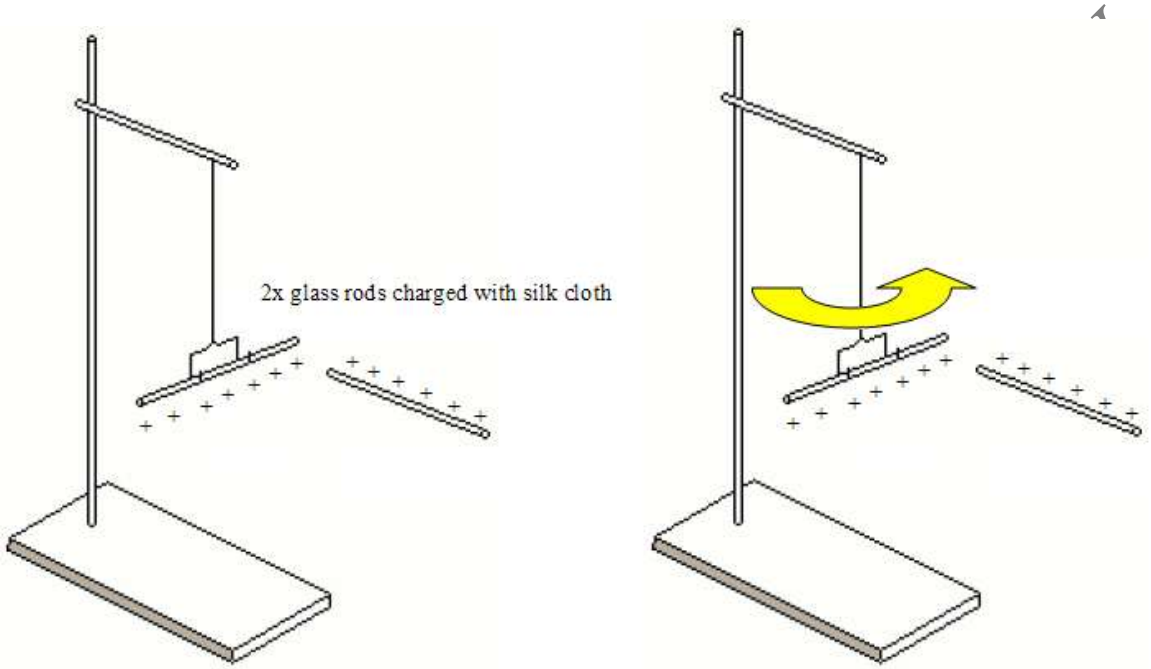
This seems to indicate that oppositely charged rods attract one another (as suspected).

<NOTE: This explains the "magic" of the Middle Ages. It turns out that magicians would use negatively charged wooden rods (called "wands"), which are good insulators (i.e., they maintain their negative charge for a long time), and attract light positively charged objects (usually sand/glass stored in silk containers or paper). Since the common person didn't understand the Physics behind electrostatic forces, the only way to describe this phenomenon was as "magical". It is interesting to note that the concept of "magical wands" still has a major role in the culture of European and American folklore. Like most folklore, it has taken on a superform – in the sense that lightning can leap from the wands (arching) or the attraction/repulsion can occur at significant distances (this would require a VERY large charge – since the force drops off like 1/r-squared). Both are "physically possible", but somewhat "unrealistic".>

- How do identically charged rods react to each other?

Analogous to the previous section, we used two glass rods charged using the silk cloth (since these were the most positively charged rods) and two PVC rods charged using the fur (since these were the most negatively charged rods).

For first the glass and then the PVC rods: We suspended one from a string and waited for it to come to complete equilibrium (i.e., no rotation/movement). We then slowly brought another similarly charged rod near the end of the suspended rod and the suspended rod end moved away from the held one.



This seems to indicate that similarly charged rods repel one another (as suspected).

Part C: Induced Charges

- Bring the negatively charged (PVC) rod near <u>but not touching</u> the metal (Aluminum) rod and then take it away.

  Electrometer reading of the metal (Aluminum) rod = _0.0 V_

- With the rod near the metal rod remove the ground cable then remove the rod.

  Electrometer reading of the metal (Aluminum) rod = + 5.2 V_

- Repeat the previous experiment but this time induce a negative charge on the metal (Aluminum) rod.

  Electrometer reading of the metal (Aluminum) rod = – 3.4 V_

Part D: Quality of Insulators

Time (sec)	Charge on Glass Rod	Charge on Wooden Rod
0	+ 5.3 V	– 8.8 V
10	+ 5.2 V	– 8.8 V
20	+ 5.2 V	– 8.8 V
30	+ 5.1 V	– 8.8 V
40	+ 5.0 V	– 8.8 V
50	+ 4.9 V	– 8.8 V
60	+ 4.8 V	– 8.8 V

- Try rubbing the metal rod with the wool cloth.

Electrometer reading = _-2 V_

Time (sec)	Charge on Metal Rod
0	– 2.0 V
10	– 0.3 V
20	0.0 V
30	0.0 V

Results and Questions

Restate your experimental results in defense of your answers.

Part A: Charge Production

- Which rod vs. cloth pairs gave the greatest negative charge?

Fur on PVC plastic

- Which rod vs. cloth pairs gave the greatest positive charge?

Silk on Acrylic

Part B: Do opposites Really attract?

- How do oppositely charged rods react to each other?

They attract.

- How do identically charged rods react to each other?

They repel.

Part C: Induced Charges

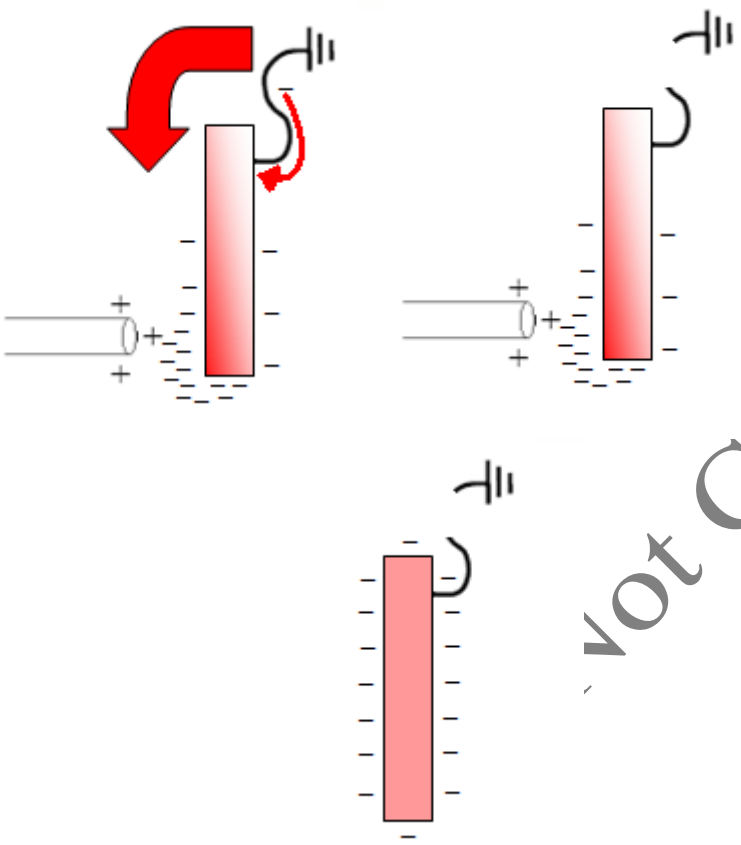
- Bring the negatively charged rod near <u>but not touching</u> the metal rod and then take it away. Did you *induce* a charge?

No.

- With the rod near the metal rod remove the ground cable then remove the rod. Have you *induced* any charge in the metal rod?

Yes.

- Explain what happened.



- Repeat the previous experiment but this time induce a positive charge in the metal rod.

- Explain what happened.

See above (but change the signs).

Part D: Quality of Insulators

- What can you say about the quality of the glass rod as an insulator?

Glass is an OK insulator. It isn't the best, since over time the charge on the glass was slowly returning to neutral. However, since it didn't completely drop to zero over the course of 1 minute, this means the glass does have some insulative properties (hence why it's used for windows and pink "insulation" – it's clear [so you can see outside] and is an

OK insulator). On a scale of 1 – 10 it's about a 7.5, I'd say. (By the way, this "scale" is called an efficiency reading).

- What can you say about the quality of the wooden rod as an insulator?

Wood is a very good insulator. Over the duration of 1 minute, it lost no charge (hence why it's used for wall construction – it keeps the cold out in winter – i.e. it doesn't absorb or radiate electron motion easily). On a scale of 1 – 10 it's about a 9.0.

- Try rubbing the metal rod with the wool cloth and take a reading with the electrometer?

Sure. See data above for part D. (I'm don't know why this was a question, lol.)

- Are you surprised by the result? Would you ever use a metal rod to insulate a charged object? Explain.

I was not surprised by the result, because I'm a Physicist; and I know how it's supposed to work.

Now for the less conceited answer:

Metal is a poor insulator (but a very good conductor). Due to this fact, electron are easily absorbed or radiated from the air to return metal to a statically neutral charge very quickly. I would never use metal to insulate a charged object.

Conclusion

- This closing paragraph is where it is appropriate to conclude and express your opinions about the results of the experiment and all its parts. Only the final result(s) needs to be restated. This part is up to you this time, see the "Write up Guidelines" link on the web page for further help.

** NOTE: There are several components of error which could significantly modify the results of this experiment. See what you can come up with in addition to some of these which may be listed below:

- Equipment Orientation/Location
- Unnecessary Movement
- Earth Ground

- Humidity
- Moistness/Dryness of hands
- Residual Charge Accumulation
- Arcing

It is recommended that you take these and explain the "***why***" part of each for your results and conclusions sections – and possibly what could have been done (if anything) to minimize the effects of these errors.