Date of Lab 02/22/2018

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Laboratory Report

Title
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Observation of Electrical Flux Line

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Summary

We placed conductors on the colored acrylic powder to observe the electric flux lines produce by charged conductors. In this experiment, we used nail, metal plate, and metal ring for conductor. We changed the charge of the conductor, so that we can observe the case of the opposite charge.

For strong charged conductors, the number of electric flux line was concentrated, while weakly charged conductors produced less concentrated electric flux line.

We also we able to observe the effect of shielding by conductors. When the charge was placed outside the metal ring, the metal ring shielded electric flux line.

By doing this experiment, I have learned that electric flux line originates from positive charge and it terminates in the negative charge.

・Meet a deadline ・Write logically ・Write clearly ・Write with your own words
・締切り守って ・論理的に ・わかりやすく ・自分のことばで

Teacher Comments

Color photos are clear and impressive

1 Due 提出期限	2 Summary 要旨	3 Intro. 序	4 Method. 方法	5 Results 結果	6 Table/Fig 表/図	7 Discussion 考察	8 Clearness わかりやすさ	9 General 全般
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* Write your report in Japanese or in English * Use this form as a cover sheet.
* Submit your reports by the seventh day after your lab.

Observation of Electrical Flux Line

Introduction:

Objective: To observe the electrical flux line produced by charged nail and acrylic color powder.

Theory:

Electric Field :

It is often said that there is an Electric Field around the charged particle. It is possible to find the direction of electric field by placing +1C of positive charged particle. The direction of the electric field is equivalent to the direction which +1C particle experiences force. Electric Field is a vector quantity.

The force that charged particle in the electric field experience can be calculated by the formula below.

$$\vec{F} = q\vec{E}$$

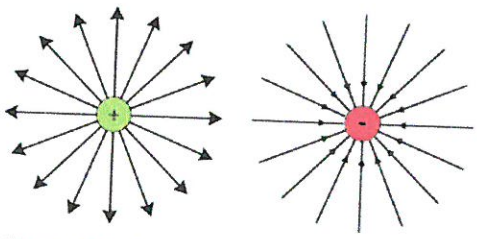
When only one particle produces an electric field, the formula to find the electric field is following formula. When there are more than one charged particles, then it is possible to find the force of electric field by combining these vectors.

$$\mathrm{E} = \frac{kQ}{r^2}$$

Electric Flux Line:

Electric Flux Line shows electric field visually. It expresses the direction of the electric field. Electric field lines originate on positive electric-charges and to terminate on negative charges. By observing the number of the lines, it is possible to know the strength of the charged particles. When the particle has lots of Electric Flux Lines, then the particle is strongly charged. Contrary, for weakly charged particles, there are only few electric flux lines.

Electric Fields of Individual Charged Particles (Point Charges):



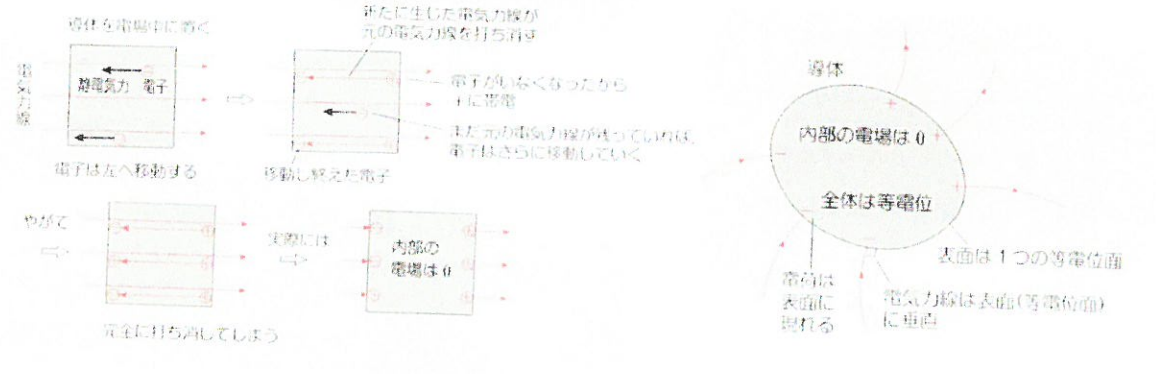
Electric field lines of a positive point charge

Electric field lines of a negative point charge

Conductor:

When a conductor is placed in the Electric Field:

1. The force of Electric Field inside of the conductor is 0.
2. All parts of the conductor are equipotential.
3. The charged particles exist in the surface of the conductor, not inside of the conductor.



Experiment:

Materials:

- Electric Tray
- Saran Wrap
- Polystyrene Tray
- Salad Oil
- Nail
- Metal Sheet
- Aluminum Foil
- Tweezers
- Old Newspaper
- Roll Paper
- Acrylic Color Powder
- Camera
- PVC rod
- Fur

Method:

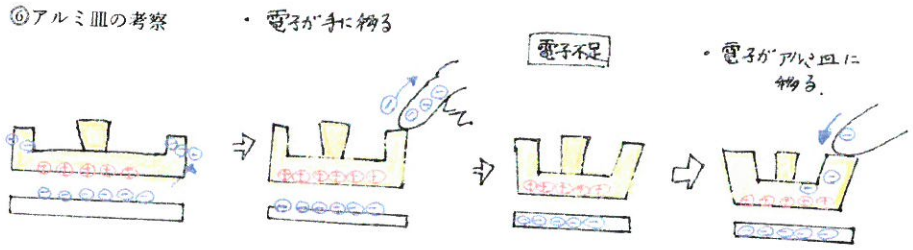
i. Spread old newspaper on the desk to keep it clean for next class.

ii. Place a polystyrene tray one the desk. Pour salad oild into the tray. Add some acrylic powder into the tray and spread it.

iii. Place two nails on the tray.

iv. Charge the nails by charged particles

A) For positive charge, use Electric Tray and Saran Wrap. Rub Saran on Styron form with paper to generate negative charge. Use the method to generate positive charge which we did last year. Reference to last year laboratory report. [Shunsuke Takeda (2017 Jpn)]



B) For negative charge, rub PVC rod by fur. The rod is now charged negatively.

v. Observe how the acrylic powder moves. Adjust the amount of oil and powder by try and

error.

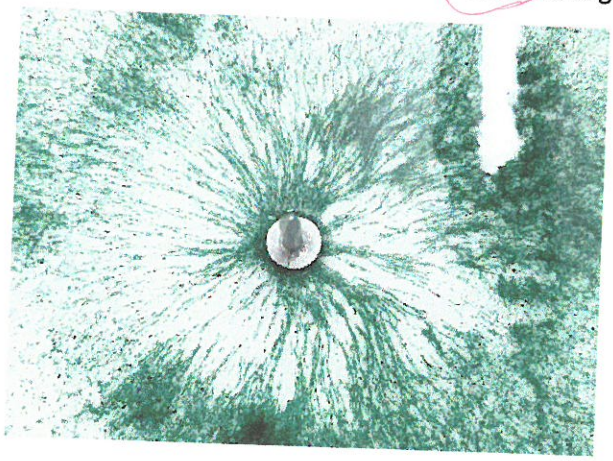
vi. Take picture of the electric flux lines.

vii. Make plate electrodes using some pieces of metal plate or aluminum foil. Use this plate instead of the nails.

viii. Repeat the same experiment examining all patterns. For example, change the charge of the nails from positive to negative.

Result and Discussion:

- Experiment #1: Charge one nail to Positive Charge



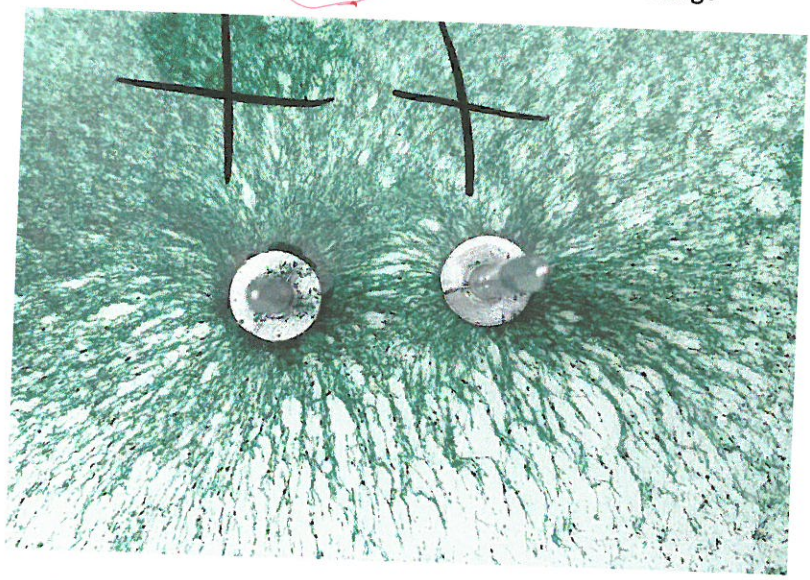
Acrylic Color Powder was attracted into the positively charged nail.

- Experiment #2: Charge one nail to Negative Charge

Acrylic Color Powder was repelled from the negatively charged nail.

My picture is not clear due to the reflect of light by oil.

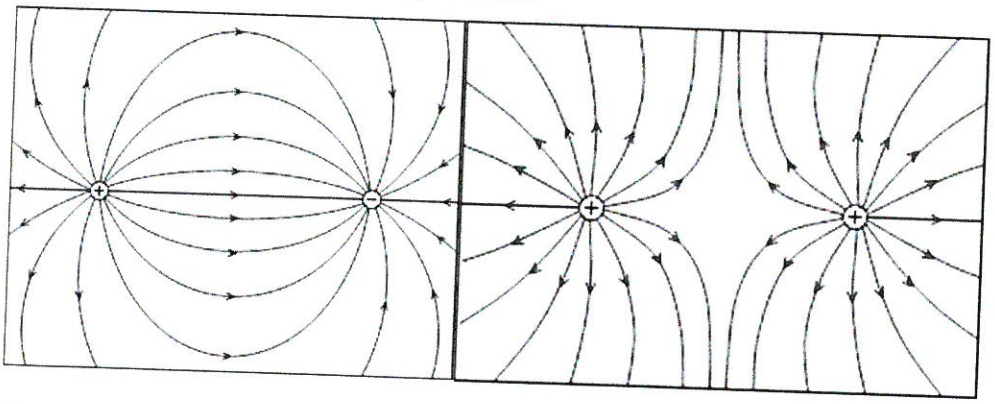
- Experiment #3: Two positive electrodes with same charge



Acrylic powder was attracted for both nails.

Although we charged both mains into positive, the right nail receives electric flux line from the left nail. This result contradicts with the theory.

Theory is shown in the figure below.

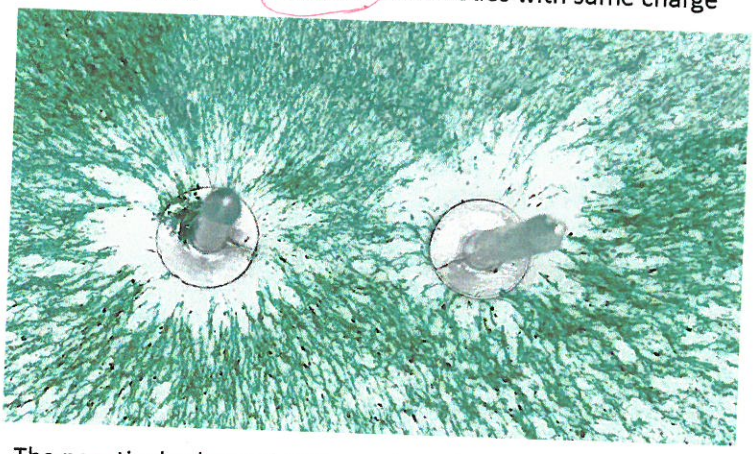


The bottom of my picture shows the reaction between Positive-Positive nails. Electric Flux Lines repel each other as shown in the theory.

The upper part of my picture shows the reaction Positive-Negative nails. Electric Flux Lines connects each other as shown in the theory. The electric flux line originate from positive nail goes into the other nail. The shape of the Electric Flux Line is bilateral symmetry, and thus it is impossible to determine whether which nail is charged positive or negative only from the picture.

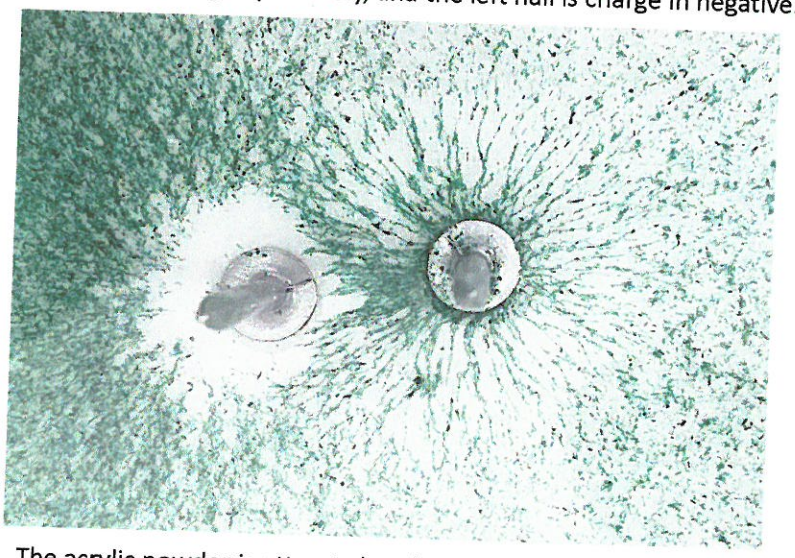
This picture is against the theory, so it is very interesting.

- Experiment #4: Two negative electrodes with same charge



The negatively charged nails repel acrylic color powder. These two nails have opposite charges, and thus there is an electric flux line which repels each other.

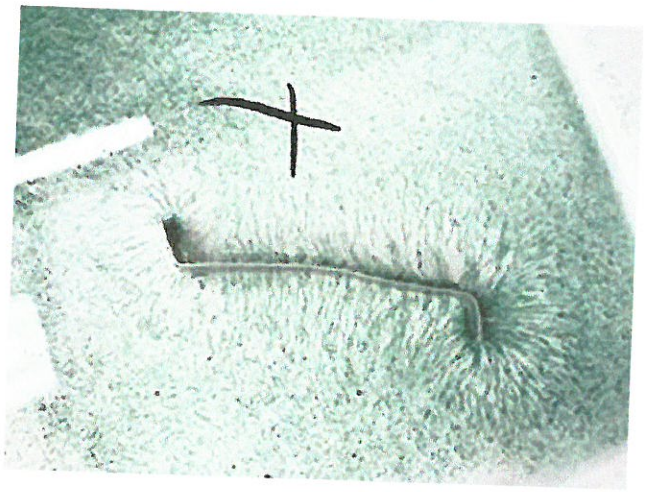
- Experiment #5: Two nails charged in opposite charges.
Right nail is charged positively, and the left nail is charge in negative.



The acrylic powder is attracted to the right nail which is charged positively. The acrylic powder is repelled from negatively charged left nail.

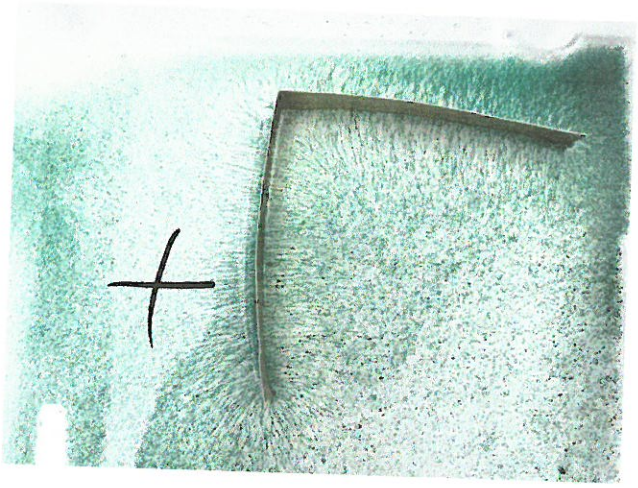
The electric flux line which originates positive (right) nail goes into the negative nail. My picture is not very clear and it does not completely match with the theory. I think this is because the charge of left nail was too strong compared to right nail.

- Experiment #6: Metal plate charged in Positive



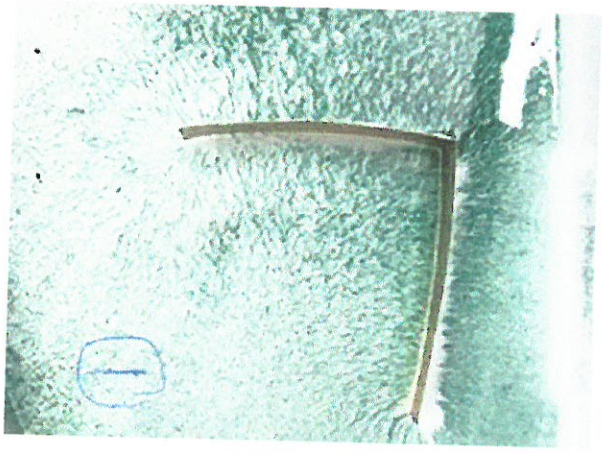
The color powder is attracted to the positively charged metal plate. The Plate is charged positively by using the electric tray. The powder shows clear electric lines.

- Experiment #7: L-shape metal plate charged in positive



The color powder was attracted into the L-shape metal.
There is no distinct difference in between the edge of the plate and the other part. The acrylic powder was attracted to the metal uniformly.

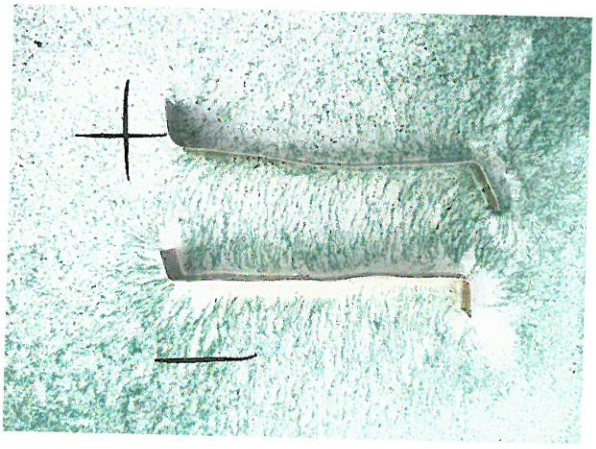
- Experiment #8: L-shape metal charge in negative



The color powder was repelled from the metal. But not all parts of the L-shape metal repelled the powder. For example, the right part of the metal repels the color powder as you can see in the picture above. Contrary, in the upper part of the L-shape metal attracts acrylic powder.

This observation is against the theory. It is usual that scientist doubt the theory when the experiment and the theory do not match. However, in this case, we did not take the grounding (アースを取る) completely. There is a possibility that the positive charge from experiment #7 was left.

- Experiment #9: Parallel plates with opposite charges



The electric flux connects the two parallel plates.

There are many straight lines in between positive and negative charged metals.

From the picture, it is difficult to identify from which metal does the electric flux line originate.

According to the theory, the electric flux line starts from positive charged metal and goes into the negative metal. This is to say that electric field starts from positive (high v) to the negative (low).

- Experiment #10: Negative Charge outside the metal ring

As we experimented in Experiment #2, the negative charged nail repels color powder. In this case, the repulsion of the powder is bit weak, so it is difficult to see the repulsion.

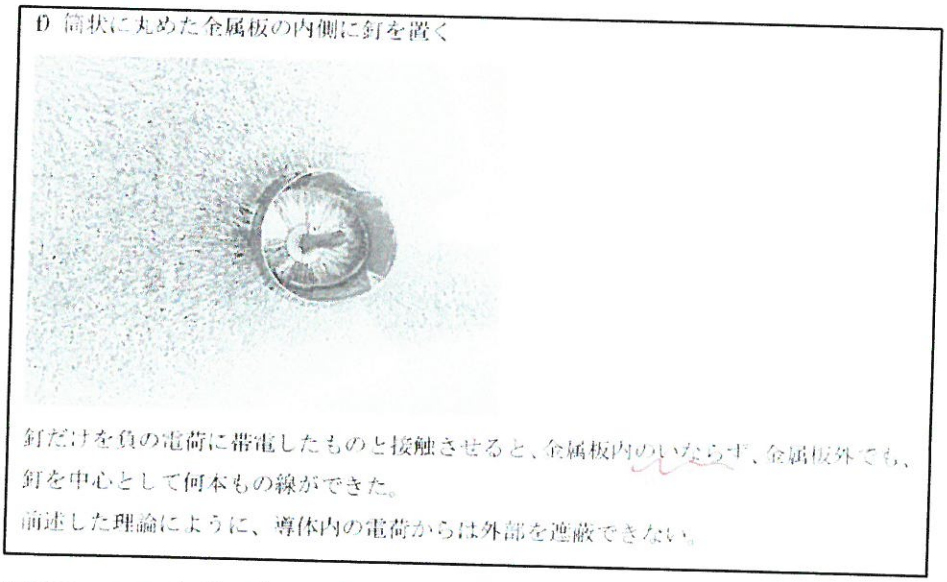
The force of repulsion does not interfere the powder inside the ring. The nail repels the colored powder around the nail, but not inside the ring. There is a shielding caused by metal ring. （静電遮蔽）

- Experiment #11: Negatively charged nail inside the metal ring

First of all, according to the theory of "Shielding", it is impossible to shield the effect of electric filed by metal ring from the inside. However, in the picture above, the ring completely shields the effect of positive charge. This is because the radius of the ring is too big, and the electric flux line does not reach to the ring.

This experiment is very inappropriate because it does not show the effect of shielding.

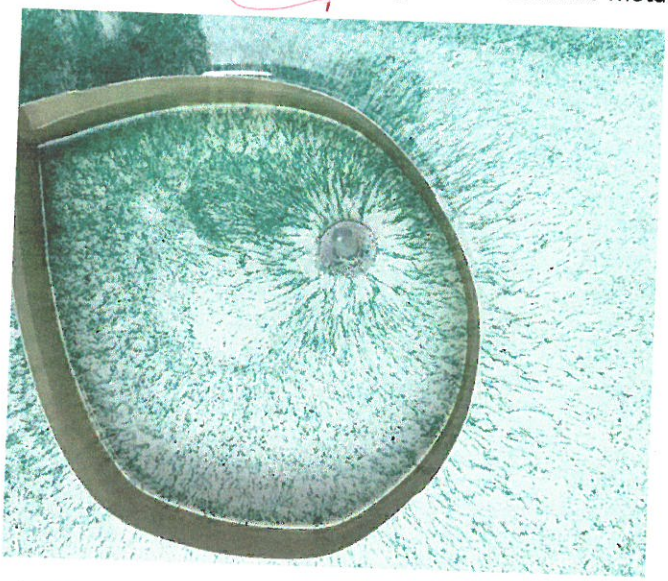
Let's see the data from 2016, Ms. Watanabe.



As you can see in the picture above, the electric flux line goes through the metal ring.

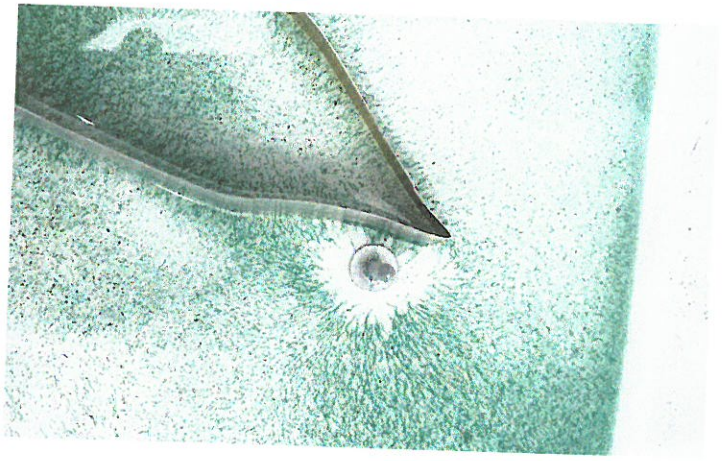
Our experimental data was not good, so we will use her data to proof the theory.

- Experiment #12: Positively charged nail inside the metal ring



As Experiment #1, the positively charged nail attracts acrylic colored powder. However, dislike Experiment #10, the metal ring does not shield the electric flux line. The electric flux line goes through the ring. As theory states, it is impossible to insulate the electric field from inside.

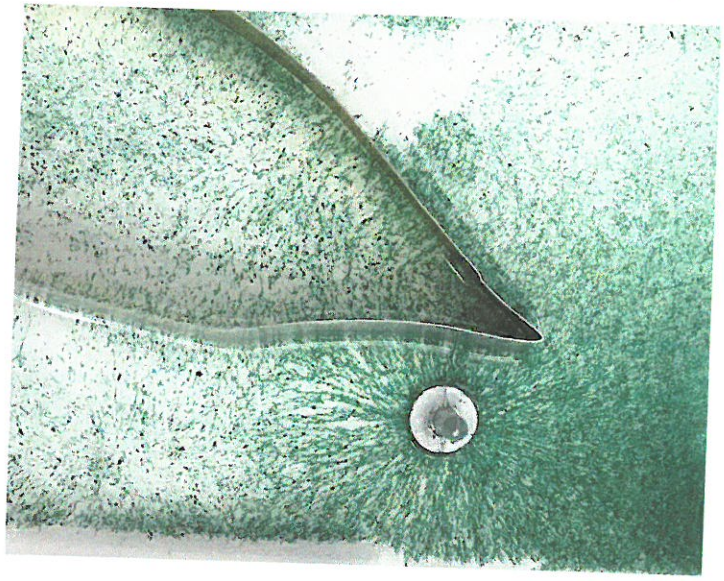
- Experiment #13: Negatively charged nail close to conductor with a sharp angle.



The natively charged nail repels colored acrylic powder.

As you can see in the picture, the space produced by metal ring is not uniform. In other word, the nail does not repel the colored powder uniformly. The nail does not repel the powder near the tip of the ring. This is because the positive charge is concentrated on the tip of the conductor, which is the ring. The tip of the ring was higher density of the charge.

- Experiment #14: Negatively charged nail close to conductor with a sharp angle.



The positively charged nail attracts acrylic powder.
Comparing the intensity of the attraction, the acrylic powder concentrates in the tip of the ring.
This is because there is more positive charge comparing to the other part of the ring.
In this case, the ring shields the electric field produced by nail. The powder inside of the ring is not attracted to the nail.

Conclusion

The point charge produces electric field around it.
Where there is an electric field, it is possible to show the electric field visually by electric flux line. In this laboratory, we used Acrylic Colored Powder to identify the electric flux lines.
When the point charge (positive or negative) is placed outside the conductor (metal ring), it is possible to shield the effect of electric field. On the other hand, it is impossible to shield the effect of electric field.

Comments

We did this experiment while Mr. Moritani was absent. It was very difficult to do the experiment without Mr. Maritain's help. We made many errors, however, there were many things which we can learn from the mistake.

Bibliography

Natsumi Watanabe 's Lab report (2016)