Date of Lab 03/01/2017 Date of Submission 03/07/2017

Laboratory Report

Title
表題 Electric Motor

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Lab Partners
共同実験者

Summary
In this lab, we created an electric motor and explored the relationships between current, magnetic field and force using Tohei's Right Hand Rule. We also conducted 5 different tests to understand how Tohe's Right Hand Rule and Right Hand Thumb Rule apply.

・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

図がわかりやすくていねいで良い．考察も良い

1	2	3	4	5	6	7	8	9
Due 提出期限	Summary 要旨	Intro. 序	Method. 方法	Results 結果	Table/Fig. 表/図	Discussion 考察	Clearness わかりやすさ	General 全般
+	+				++	++	+	++++

* 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.

<Introduction>

Objectives:

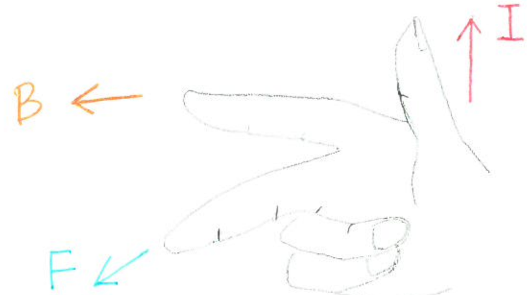
1. To learn how to create an electric motor
2. Make the electric motor spin

Theory:

- Electric current always flows from positive to negative
- The direction of magnetic field is determined by the direction that the north pole of a compass points

Tohei's Right Hand Rule (motor)

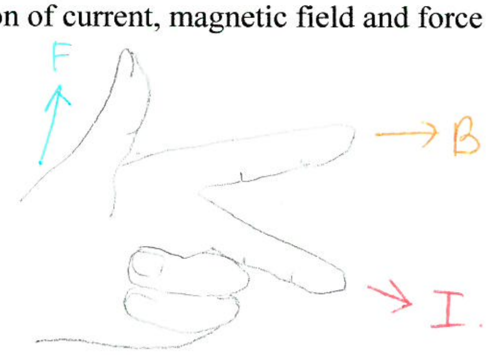
- Thumb represents the direction of current, index finger represents the magnetic field and the middle finger represents force
- Determines the direction of current, magnetic field and force using right hand



Tohei's Right Hand Rule

Fleming's Left-Hand Rule (motor)

- Thumb represents force, index finger represents magnetic field, the middle finger represents electric current.
- Determines the direction of current, magnetic field and force using right hand

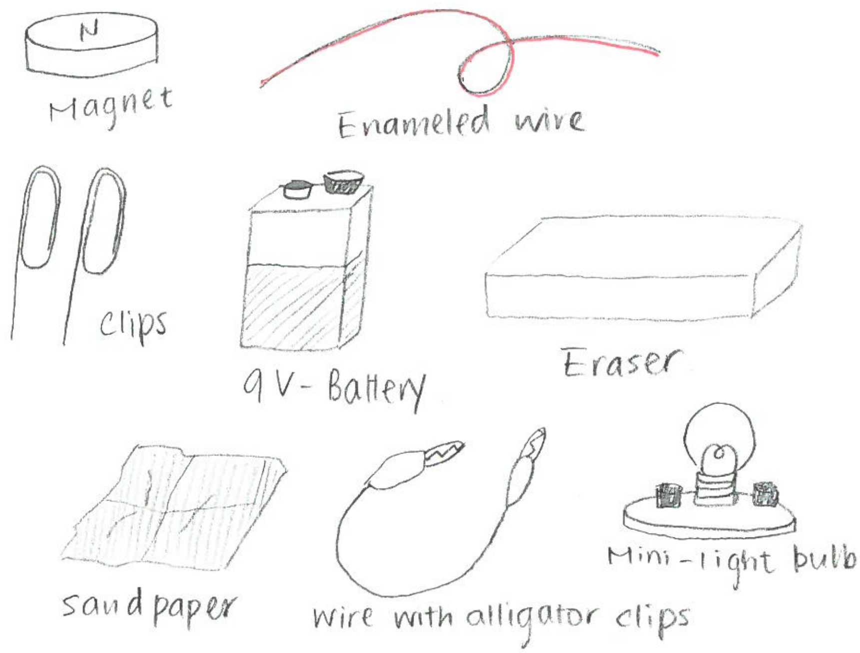


Fleming's Left Hand Rule

<Experiment>

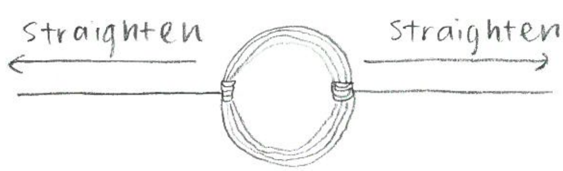
Apparatus:

- Magnet
- Enameled wire
- Clips x2
- 9V-Battery
- Easer
- Knife
- Sand paper
- Wire with alligator clips
- Mini-light bulb

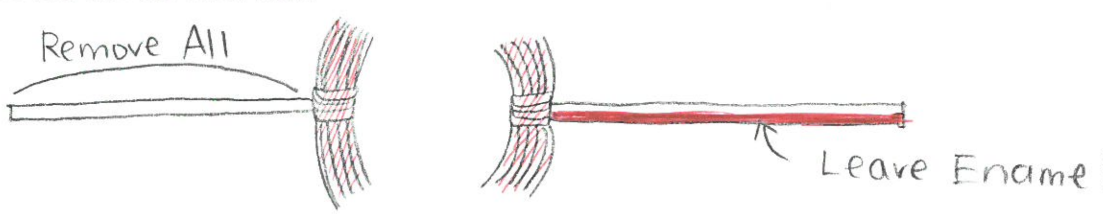


Methods:

1. Begin making a coil by winding a wire up around a cylinder.
2. Tie the coil. Do not use the end of the wire to tie the coil because this part of the wire will become the shaft.
3. Balance the coil by adjusting and straightening the ends of the shaft.

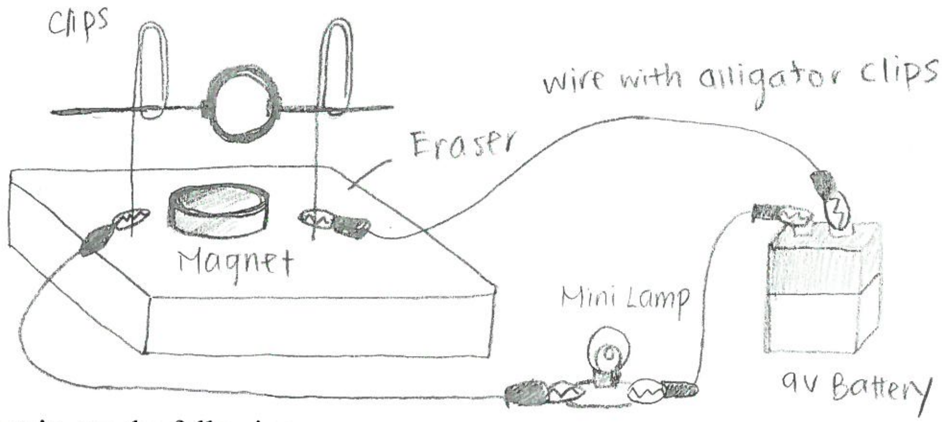


4. Remove enamel as shown. Remove all the enamel for one side but only remove enamel on one side for the other side.



5. Assemble on an eraser, as shown. Stick to clips to the eraser and place a magnet in

between it. Attach a wire with alligator clips on both clips and connect the to a 9-V-mini lamp as well as 9-V battery.



6. If it does not spin, try the followings:
   a) to arrange balancing
   b) to reduce the clearance between the coil and magnet
   c) add more magnetes
7. If the coil spins well, try the following:
   a) switch the plus and minus terminals in the battery
   b) check which parts are N and S poles and switch them
8. Examine the principle of electric motor.

<Results>

- I was not able to make the motor turn in the beginning with my first motor and so I decided to make a new coil. At the end of the class, my friend helped me to fix the motor and the motor was able to spin.

Table. 1 Results of the motor experiment

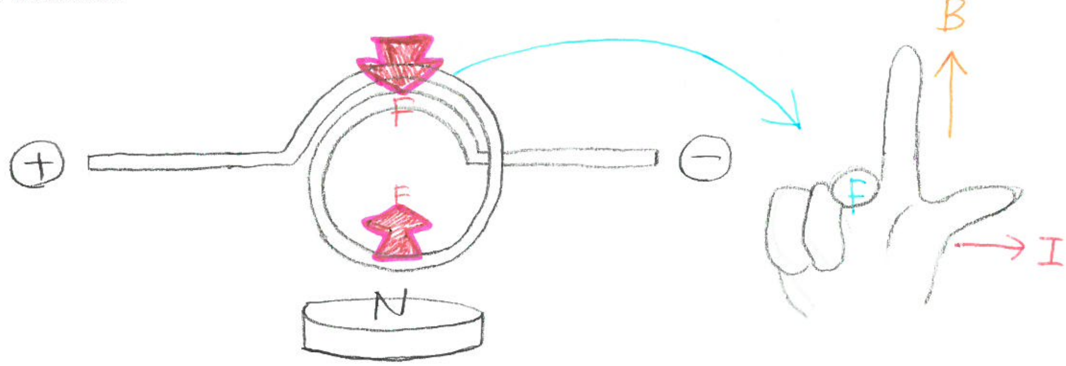
#	Charge on the right	Charge on the left	Direction of the current	Magnet	How top part of the motor span
1	-	+	From left to right	N facing up	Inward
2	-	+	From left to right	S facing up	Outward
3	+	-	From right to left	N facing up	Outward

4	+	-	From right to left	S facing up	Inward

1. There was negative charge on the left and positive on the right. When the north pole of the magnet was facing the motor, it made it spin inwards. The light bulb blinked while it span.

<Discussion>

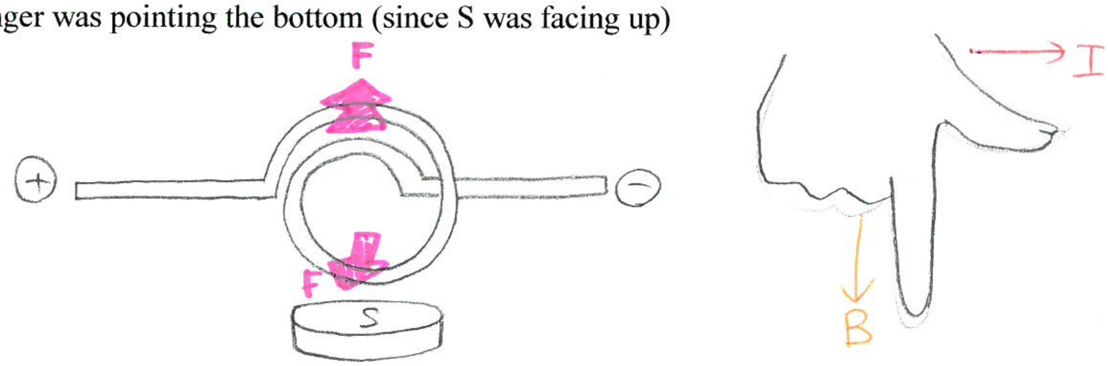
Because the flow of current is from left to right, the thumb points to the right. Since the North Pole is facing up, the index finger points upwards. Therefore, the direction of the force is inwards.



2. The negative charge was placed on the left and positive on the right. When the South pole of the magnet was facing the motor, the top part of the motor span outwards.

<Discussion>

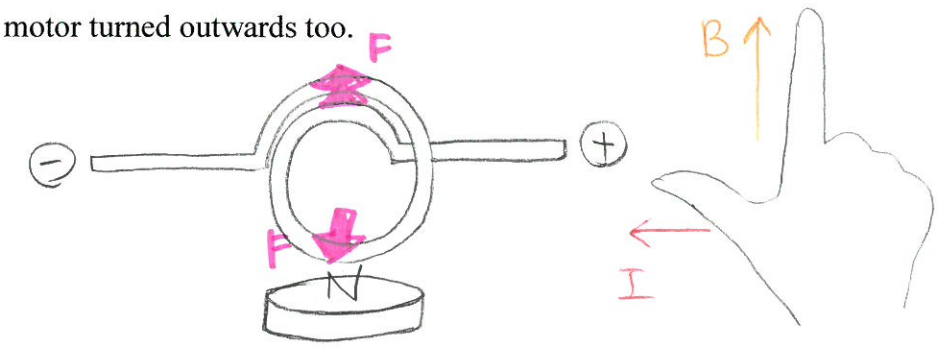
As the current flowed from left to right, the top part of the motor span outwards. This was due to the Tohei's Right Hand Rule, where the thumb was pointing the right and the index finger was pointing the bottom (since S was facing up)



3. With positive on the right and negative on the left, the top part of the motor moved inwards. The light bulb flashed.

<Discussion>

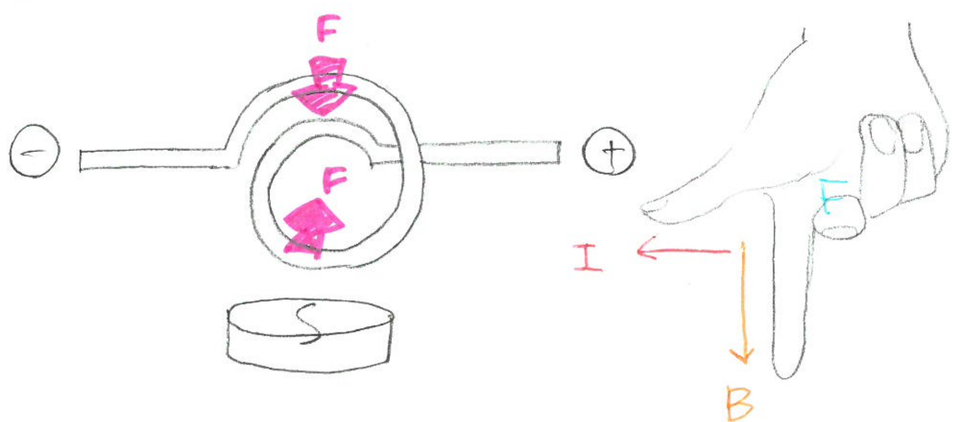
In this test, the current flowed from right to left. Therefore, the thumb points the left. The index finger points the coil since the N is facing up. As the force was pointing outwards, the motor turned outwards too.



4. The positive was place on the right and the negative on the left. The north pole of the magnet was facing upwards. The top part of the motor span inwards and the bottom part went outwards. The light bulb was not always lit up but it was flashing.

<Discussion>

The current was flowing from right to left, as represented by the thumb. The index finger points the eraser as the South Pole was facing upwards. Therefore, the top part of the motor turned inwards.



<Discussion>

Why did my motor not spin in the beginning?

One of the reasons why my first motor did not turn was probably because I had not removed the enamel completely. When the enamel is not taken off as much as possible, it insulates the electric current and does not let current flow or light up the light bulb.

Another reason was that the motor did not have enough balance. One side of the circular coil was heavier than the other side and prevented the coil from turning. When I adjusted the position of the shaft using the new coil that I made, it became more balanced and it was able to turn. The coil would not turn when the shaft is not straightened as much as possible too.

This did not apply for my motor, but some might start spinning after changing the magnet. If the magnetic fields of the original magnet were not strong enough for the coil, it would not begin to turn. However, by using a magnet with a stronger magnetic field, it would make it turn or turn faster if the coil was spinning slowly as stronger magnetic field results in stronger force.

Why do you only remove the enamel for one side?

By only removing the enamel on one side, it allows the motor to turn continuously. If both sides of the shaft's enamel were completely taken off, it would not make the motor turn 360 degrees because one side would try to make the coil move inward and the other side would make it turn outwards. If one side of the shaft is half-enameled, the part with the enamel becomes an insulator and allows the coil to turn in the same direction continuously due to momentum. This was why the light bulb was flashing when the coil turned. Whenever the part with enamel touched the clip, it stopped the flow of electric current.

Experiment 2

<Introduction>

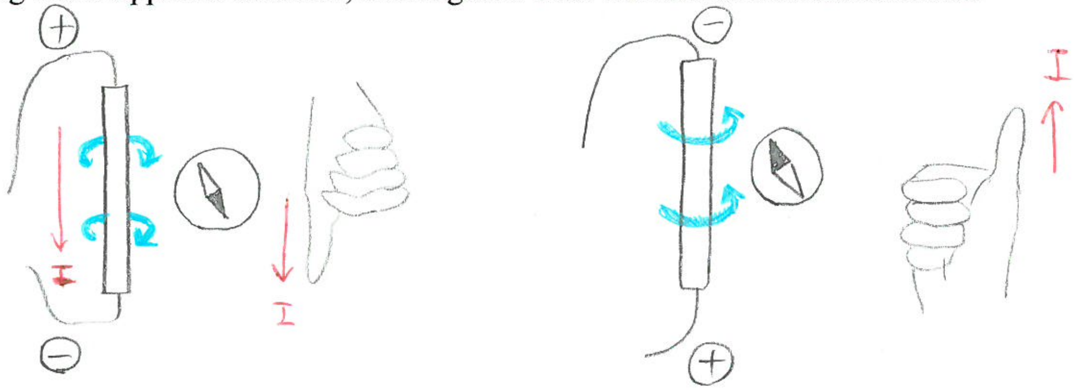
Objectives:

1. To learn how to use Tohei's Right Hand Rule
2. To learn the relationships between current, magnetic field and force.

Test 1: Magnetic Field created by a wire

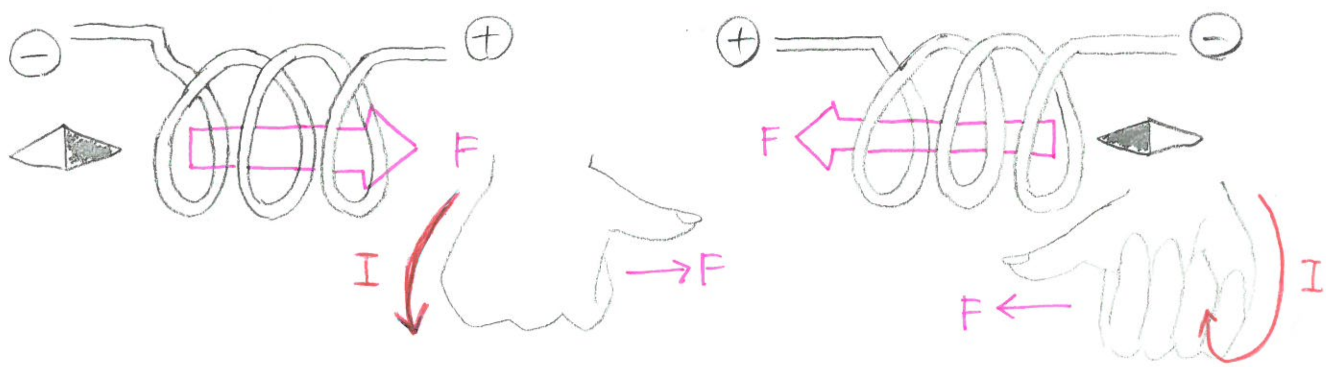
When the current was flowing from top to bottom, the North Pole moved to the right (it got closer to me). When the current was flowing from bottom to top, it made the north pole of the compass to go to the back and tilt to the right.

Based on Right-Hand Thumb Rule, when the current moves from top to bottom, thumb will point down with magnetic field turning clockwise. Therefore if the current is flowing in the opposite direction, the magnetic field would turn counterclockwise.



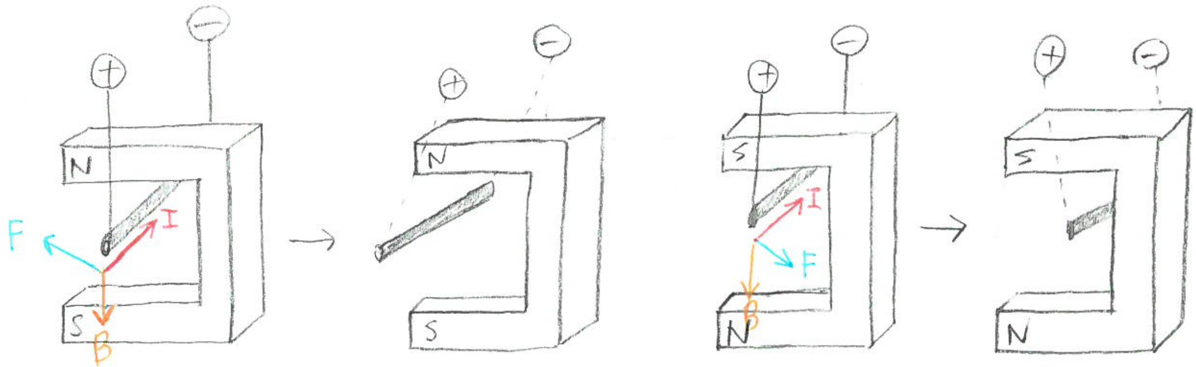
Test 2: Magnetic Field created by a coil

This is based on the Right-Hand Thumb Rule. The current in the coil flows from the front to the back (right to left), so the magnetic field points to the left. When the current in the coil flows from the back to the front (left to right), the magnetic field points to the right as shown in the image below.



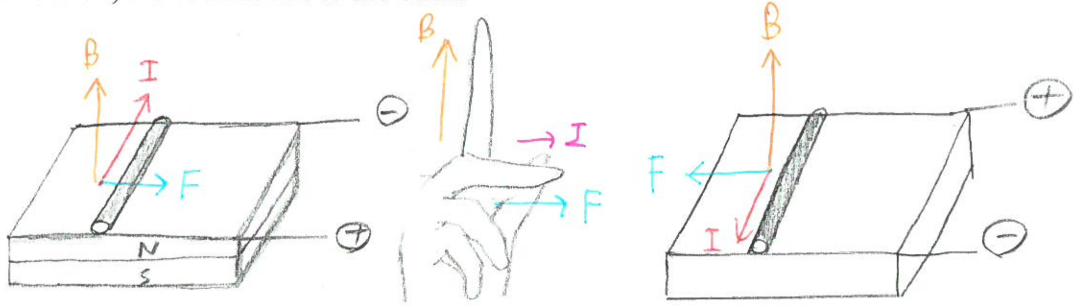
Test 3: Magnetic Field created by a U-shaped magnet

In this test, the current was flowing from right to left (positive charge on the right and negative on the left). When the magnet was placed near it with its North Pole above the foil, the foil moved away from the magnet. However, when the South Pole was positioned above the foil, the foil moved inwards. This force involves the Newton's third law of motion.



Test 4: Linear Motor

In this test, we experimented how a metal rod moves on a linear motor depending on the direction of the current. When the positive charge was on the right, the rod moved to the front due to Tohei's Right Hand Rule. When the current flowed in the opposite direction, the rod moved to the back.



Crooke's

Test 5: Crook's Tube

When magnetic field applied from the top, the electron beam moved either to the right or left depending on the pole that were put close to the Crooke's tube. However, when a magnet is put near it from its sides, the electron beam moved up and down.

Because the direction of the flow of electrons is opposite the direction of current, the current is flowing from the opening of the tube to where the electron beam is coming out of in this test.

Diagram on the next page

<Conclusion>

- The direction of current, magnetic field and force can be found using Tohei's Right

Hand Rule if two of the factors are known

- The direction in which the coil turned changed depending on the direction of the magnetic field as well as the electric current
- The coil continued to turn because one side of the shaft was only half-enameled. This part acts as an insulator and the coil is able to keep moving because of momentum.
- Right-Hand Thumb Rule can be used to identify the direction of a magnetic field

<Opinion>

I felt this was the most difficult lab out of all the labs we did in class because I was not able to get the coil turning until the very end when my friend fixed my motor. I noticed how different components such as how much balance it has, how much enamel were taken off, how strong the magnetic field is contribute in creating a successful motor. I felt a great sense of achievement when I was able to create a motor that works properly. Through this lab, I was able to gain a clearer idea of how Right-Hand Thumb Rule and Tohei's Right Hand Rule applies to various materials.

Tohei

<Reference>

Riki Nakayama san's Lab Report
Hirokazu Matsuda san's Lab Report

Test 5.
Crooks Tube