EXPERIMENTS IN MAGNETISM

Prepared By The Rosicrucian Order, AMORC

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Preliminary Instructions

You will find accompanying these instructions as a supplement, a complete list of all equipment supplied in this laboratorium. Included with the supplement you will also find a list of illustrations, which provide pictorial representations of the various items and the equipment. Before you commence with your experiments check over this list and make certain that you are well acquainted with the appearance of the various objects. This procedure will avoid later misunderstandings. The materials supplied have been carefully checked by our laboratory staff before they were placed into the laboratorium.

You will note that in addition to the articles supplied you, it will be necessary for you to obtain a large glass or porcelain bowl, filled with water, and a few other items. These materials were not included because they are either available in your home or are easily purchased at your local store at a very small cost. Another reason why we did not include them is that their inclusion would have raised the price of packing and shipping. It has been our aim to provide you with your laboratorium at the lowest possible cost.

After you have checked your equipment and have become quite familiar with it, read the Introduction on pages two, three, and four. This concise introduction will acquaint you with the fundamental laws and principles of magnetism, most of which you will be verifying in your experiments.

As soon as you have completed your study of the Introduction you will be well prepared to commence with your experiments. For a workbench select a large steady wooden table. Remove from this table all metallic objects which might disturb your experiments by their magnetism. It is suggested that your working table should be absolutely empty before you start. Place the items which you require upon this table. There should be no other objects upon it aside from your materials and these instructions. This procedure will aid you in keeping system and order. Before you commence any experiment, first read through the entire text pertaining to the experiment which you intend to perform, so that you are thoroughly familiar with the procedure. Obtain a small notebook into which you can record your observations for future reference.

At the end of most experiments you will find a list of questions. These questions have been added to stimulate your thinking. DO NOT SEND THE ANSWERS TO YOUR QUESTIONS TO THE GRAND LODGE. The instructions provided with this laboratorium are complete. The purchase of this laboratorium does not carry with it any privilege of writing for further information. However, if you should desire such information, send such a question to the librarian of the Rosicrucian Research Library, who will answer you, subject to the procedure and nominal charge established for this purpose.

When you have completed an experiment you will find it helpful to replace the various objects into their envelopes, unless they are needed in the following experiment. Remember the Rosicrucian Law: "System and Order."

Study the various laws and principles of magnetism, as stated in your Monographs. You will find the indexes, supplied by the Rosicrucian Supply Bureau, of great help in locating this information. Also read the article "The Magnet" in the Rosicrucian Manual. This will provide additional help in your magnetic studies.

INTRODUCTION

The study of magnetic phenomena is of special importance to us as Rosicrucians, because they visually demonstrate in the simplest possible manner the behavior of objects which are in a polarized condition. It is the fact that a polarized object is able to affect the space surrounding it, creating what is known as a "field of force" or "aura," which makes such phenomena worthy of our special attention and study. It is for this reason that the AMORC LABORATORIUM No. 1 is devoted to the study of magnetism.

As an introduction to the various experiments which the student is to perform we state, with extreme brevity, the fundamental laws of magnetism.

It can be shown that certain substances such as iron, cobalt, nickel, and some of their ores and alloys have the power of attracting other small pieces of the same substances. This force of attraction, requiring apparently no material medium through which to act, is called a "magnetic" force; and the objects which are capable of exerting such a force are called "magnetic" objects, or simply "magnets." Substances which can be magnetized, using proper procedures, are also called "ferromagnetic." A ferromagnetic substance is a substance which is strongly attracted by a magnet. It also shows the property commonly known as "retentivity." This is the ability of a magnetized substance to retain its magnetism.

There are other kinds of magnetism beside ferromagnetism. But these other types are too weak to be observable under ordinary conditions, and we shall not be concerned with their properties in this brief introduction.

When a magnet is examined it is found that its magnetic properties (its ability to attract) are concentrated at definite regions or centers of the magnet. These regions are called the "poles" of the magnet. Every magnet possesses at least two poles.

When a magnet is suspended by a string so that it can swing freely then it will be observed that it moves in such a manner that the line between its strongest poles is approximately parallel to the geographic north-south direction. No matter how the magnet is moved, it will always swing back into this alignment. That pole of the magnet which points toward the geographic north pole is called the "north-seeking" pole, or the "north pole," while the other pole of the magnet is called the "south-seeking" pole or the "south pole." Due to the fact that a magnet, when allowed to swing freely, will always align itself along the same direction, it may be used as a compass.

The north and south poles of a magnet are of equal strength. When any magnet is broken into two pieces, then each part becomes a complete magnet, having a north pole and a south pole. No one has ever been able to discover or produce a magnet with only a single pole. This fact has led to the theory that each of the molecules, of which a ferromagnetic substance is composed, may be considered as being a very small elementary magnet. When a ferromagnetic substance is in an unmagnetized state, all these elementary magnets are oriented at random, thus neutralizing their effects, while in a magnetized object these elementary magnets are all oriented along the same direction; that is, all north poles are pointing together, and similarly for the south poles.

It has been mentioned above that every magnet possesses two distinct polarities: a north pole and a south pole. Usually these poles are located near the ends of the magnet, but that is not always necessary.

The magnetic poles obey the fundamental law of polarities, which is: Unlike polarities attract; like polarities repel one another. Using this law the polarities of an unknown magnet may be tested and determined by observing the attractions or repulsions which occur when this unknown magnet is brought into the neighborhood of a second magnet, the polarities of which are known.

There are three methods by means of which an unmagnetized ferromagnetic substance may be magnetized. These methods are (1) by frictional contact (see experiment 4), (2) by the method of magnetic induction (see experiment 14), (3) by means of an electric current (see experiment 18). For a description of these methods consult the experiment indicated within the brackets. In each of these methods a magnet is created which possesses two distinct poles.

Iron and steel are the only two common substances which are ferromagnetic and thus attracted by a magnet. Certain kinds of ferromagnetic substances are able to retain their magnetism and become permanent magnets. The ability of a substance to retain its magnetism is called the "retentivity." Soft iron has a low retentivity; steel possesses a high retentivity.

A magnetic force is able to act through many substances, such as paper, cardboard, or glass. However, iron acts as an effective magnetic screen if it completely encloses the substance which is to be screened.

Each magnet is able to affect the space surrounding it and subject any other ferromagnetic substance to its influence. Thus a magnet creates what is called a magnetic "field" or an "aura." When iron filings are sprinkled around a magnet these filings align themselves under the action of the magnetic field, affording in this manner a very clear objective picture of the magnetic field. Various combinations of magnets will produce different types of fields. Pictures of such fields are provided in this manual and also in the Rosicrucian Manual. They also afford interesting pictures, showing how the aura due to one magnet may be modified by the presence of a second magnet.

There are three ways in which the magnetism of an object may be destroyed: (1) extreme heat, (2) great mechanical strains and jars, and (3) the application of an alternating current. It is the last method which is commercially used in demagnetizing objects.

This concludes the brief introduction into the laws and principles of magnetism. For further study the student should consult any textbook on general physics, where he will find much additional information which will be of interest to him in his Rosicrucian studies.

OUTLINE OF EXPERIMENTS

Experiment No. 1

It is the purpose of this experiment to demonstrate that (a) a lodestone has the power to attract small pieces of iron, (b) the magnetic force is concentrated at certain definite regions of the lodestone, called the "poles."

Materials: Large sheet of paper. Iron filings. Lodestone. (See A, B, and C on pictorial list for illustrations of equipment.)

Procedure: Place a large sheet of paper upon the table. Open the bottle which contains the iron filings and spread two teaspoonfuls of the filings upon the sheet of paper. Now take the lodestone and immerse it completely within the iron filings, so that all of its sides are touched and nearly covered with the filings. Remove the lodestone and inspect it carefully.

Results: You will note that the iron filings stick to the lodestone, demonstrating that such a stone has the property to attract small pieces of iron. At the same time you will observe that the filings cling more densely to certain spots of the stone than to others. This demonstrates that this force of attraction, or "magnetic" force, is concentrated at definite regions. These regions are called the "poles" of the magnet.

Questions:

1. How many poles does your lodestone possess?
2. What are the directions in which the various particles of iron point? Do these various directions provide additional clues as to the nature of the magnetic force?

Note: When you have completed this experiment scrape the iron filings from the lodestone and pour all the iron filings back into the bottle, to be used in future experiments.

Experiment No. 2

It is the purpose of this second experiment to demonstrate that when a lodestone is suspended freely then it will rotate into such a position that its strongest poles will line themselves up along the geographic

Experiment No. 2 (Continued)

north-south direction. The lodestone thus serves as a "leading stone" or a magnetic compass.

Materials: Lodestone. Sheet of paper with iron filings. String. White sheet of paper. Pen and ink. (See A, B, C, F on pictorial illustration sheet for pictures of the equipment.)

Procedure: Draw a straight line upon a sheet of paper--about four inches long. Mark one end of the line "North" and the other end "South."

Determine the geographic north-south direction in your room. Then place the sheet of paper which you have prepared so that the line drawn upon it coincides with the geographic north-south direction.

Next dip the lodestone into the iron filings. This will provide you with a clear indication of the location of its poles. (See experiment 1)

Fasten a string around the lodestone. The string should be so tied around the stone that the strongest poles are horizontal and remain so. (See figure 1, Experiment Illustrations) Hold the free end of the string with your hand, about half way up. Let the stone hang freely from the string above the north-south line which you have just drawn. Make certain that the stone does not touch any object and also be sure that no other magnetic objects are located in the vicinity of the stone.

Results: You will observe that the stone will line itself up along a definite direction. Note the location of the strongest poles. Turn the stone slightly and observe that it will swing back into its former position.

Questions:
1. How does the direction of your north-south line on the paper agree with the position of the strongest poles?
2. Where are the weak poles located?
3. How could you construct a compass, using this arrangement?

Note: When you have completed this experiment scrape the iron filings from the lodestone and pour all iron filings back into the bottle.

Experiment No. 3

The purpose of this experiment is to find the poles and the neutral region of a horseshoe magnet.

Materials: Sheet of paper. Iron filings. Horseshoe magnet. (See D, B, C on pictorial list of equipment.)

Experiment No. 3 (Continued)

Procedure: Place a sheet of paper upon the table. Open the bottle containing the iron filings and spread the filing upon the paper.

Remove the horseshoe magnet from its wrapper. Remove the small cross bar (also called the "keeper"), which protects its ends.

Immerse the magnet completely--all sides and ends--in the iron filings.

Pick up the magnet with the filings clinging to it and inspect it carefully.

Results: You will observe that the filings cling firmly to the two ends of the magnet. These are the two centers of magnetic attraction of the magnet and are called the "poles." You will also note that practically no filings cling around the curved part of the magnet. This region is called the "neutral region" of the magnet.

This experiment demonstrates that the poles of a horseshoe magnet are located at its ends and that there is no magnetic force of attraction at the center of the magnet.

Question 1. How could you use the horseshoe magnet as a compass?

2. Why is it not practical to use it as a compass?

Note: When you have completed the experiment, remove the filings from the magnet and return them to the bottle.

Experiment No. 4

The purpose of this experiment is to show how an unmagnetized object, made of steel, may be magnetized by frictional contact.

Materials: Paper with iron filings. Horseshoe magnet. One unmagnetized steel needle. (See C, B, D, E on illustration sheet of equipment.)

Procedure: Remove the steel needle from the package, and immerse its full length into the iron filings. Observe that the filings will not cling to the needle, demonstrating that it is not magnetized.

Now place the needle upon the table. Take the horseshoe magnet (remove the keeper) and, holding it in your hand, place one of the poles upon the end of the needle. (See figure 2, of experiment illustrations) Now rub the pole along the needle until you reach the needle's other end. Make certain that only one pole of the horseshoe magnet touches the needle.

Experiment No. 4 (Continued)

Remove the horseshoe magnet from the needle, and place the pole back where you first touched the needle. Rub the needle once more. Repeat this procedure, rubbing the steel needle with the same pole of the horseshoe magnet and always rubbing in the same direction. Do NOT rub the needle back and forth.

Repeat this procedure for approximately ten minutes. Now cover the steel needle with the iron filings. Remove the needle and inspect it carefully.

Results: You will observe that the filings cling to the two ends of the needle. This demonstrates that the needle has become magnetized and that it now possesses two poles, one at each end. You will also observe that there is a neutral region between the two poles.

Question: What would occur if the needle were rubbed with both poles of the magnet touching it simultaneously?

Note: Upon completion of the experiment, remove the iron filings from the needle.

Experiment No. 5

The purpose of this experiment is to locate the North and South poles of a magnet.

Materials: Magnetized steel needle of experiment 4. Wooden block. Copper staple. String. Two small paper squares, one blue, the other red. Pen and ink. Nail. Sheet of paper, with a pencil line, marked "North-South," prepared in experiment 2. (See E, G, H, F, I, J, K, C of pictorial list of equipment.)

Procedure: With pen and ink mark the blue paper square on both sides with the capital letter "N" and also mark the red square with the capital letter "S." Pierce two small holes through the top of the squares so that they may be attached to the steel needle. (See figure 3)

Take the copper staple and push it firmly into the top of the wooden block. (See figure 4)

Again determine the geographic north-south direction in your room. Place the sheet of paper upon which you have drawn the pencil line (See experiment 2) upon the table in such a manner that the line drawn upon the paper coincides with the geographic north-south direction.

Now pierce the magnetized needle lengthwise through the wooden block until the block is situated at the center of the needle. Fasten a string to the staple and hold this

Experiment No. 5 (Continued)

string in such a manner that the needle may move freely in space. Push the needle back and forth in the block until the needle swings horizontally. Hold the string in your hand and let the needle swing freely in space.

Results: You will observe that the needle lines itself up along the geographic north-south direction. The pole which is pointing toward the geographic north is called the "north-seeking," or north pole. The pole which is pointing toward the geographic south is called the "south-seeking," or south pole. Attach the blue square, marked "N" to the north pole of the needle, and attach the red label, marked "S" to the south pole of the needle. (See figure 5.)

Questions: 1. What is the magnetic polarity of the geographic north pole?

2. Does the geographic north pole coincide with the corresponding magnetic pole? (Hint: use the law of polarity, experiment 7.)

Note: After the experiment has been completed remove the string from the staple.

Experiment No. 6

The purpose of this experiment is to demonstrate that the north and south poles of a magnet are of equal strength.

Materials: Large bowl with water. Use the same magnetized steel needle, with labels and cork, just used in experiment 5.

Procedure: Remove the string from the staple. Float the magnetized needle with its wooden block in a nonmetallic (glass or porcelain, rubber) bowl of water. Make certain that the needle does not touch the edges of the container. Use a container large enough for needle to turn in. Have a depth of water of at least two inches.

Results: Observe that the needle lines itself up along the geographic north-south direction. Thus, in this arrangement the needle serves as a simple magnetic compass.

Also observe that the needle, once it has assumed the north-south direction remains perfectly quiet. This proves that the magnetic force which acts upon the north pole is equal to the magnetic force acting upon the south pole. The needle is perfectly balanced. Hence it follows that the north pole and the south pole of a magnet are equal in strength.

Questions: 1. What would occur if, for some reason, the north pole of the needle were stronger than its south pole?

Experiment No. 6 (Continued)

2. Bring the end of the steel needle near the wall of the bowl. Do you observe an attraction between bowl and needle? Is this attraction due to cohesion, or is it due to adhesion?

Note: This arrangement of the needle floating in the bowl of water will serve as an indicator of magnetism in future experiments. Such an arrangement is also called a "Magnetoscope." This arrangement will be used in experiments 7, 8, 10, 16, and 17.

Experiment No. 7

The purpose of this experiment is to verify the fundamental law of polarity: Like polarities repel; unlike polarities attract one another.

Materials: Magnetoscope of experiment 6. (Magnetized needle with labelled polarities, floating within a bowl of water.) Unmagnetized steel needle (E). Two paper squares (I, J), one blue, the other red. Wooden block (G). Copper staple (H). Pen and ink. String (F). (The capital letters placed in parenthesis refer to the pictorial list of illustrations.)

Procedure: Magnetize the second steel needle, using the method of experiment 4.

Pierce the needle through the wooden block to which a staple has been attached and determine the needle's north and south poles, following the procedure of experiment 5. Attach a label, marked "N" and another marked "S" to the proper poles of the needle. Follow the method outlined in experiment 5. Remove the string and the staple. You now possess two magnetized steel needles, the polarities of which have been determined.

Approach the south pole of the floating magnetic needle with the north pole of the other steel needle. Note the result. (See figure 6.)

Approach the north pole of the floating magnet with the north pole of the steel needle. Note the result.

Results: Observe that when the south pole of the floating magnet is approached by the north pole of the steel needle there manifests an attraction between the two poles. This demonstrates the first law of polarity: Unlike polarities attract one another.

Also observe that when the north pole of the floating magnet is approached by the north pole of the steel needle, then the two poles tend to move apart. This proves the second law of polarity: Like polarities repel one another.

Experiment No. 7 (Continued)

Questions: 1. What should occur if the north pole of the floating magnet is approached by the south pole of the other steel needle?

2. Verify your conclusion by the proper experiment.

Experiment No. 8

The purpose of this experiment is to find the north and the south pole of the horseshoe magnet, using the law of polarities.

Materials: Magnetized steel needle, properly labelled, floating within a bowl of water (Magnetoscope of experiment 6). Horseshoe magnet (D). Pen and ink.

Procedure: Set up the magnetoscope, as described in experiment 6. Take the horseshoe magnet and approach the north pole of the floating magnet with one of the poles of the horseshoe magnet.

Observe whether an attraction occurs, or whether there manifests a repulsion.

Pierce the needle through the wooden block to which a staple has been attached and determine the needle's north and south poles, following the procedure of experiment 5. Attach a label, marked "N" and another marked "S" to the proper poles of the needle. Follow the method outlined in experiment 5. Remove the string and the staple. You now possess two magnetized steel needles, the polarities of which have been determined.

Approach the south pole of the floating magnetic needle with the north pole of the other steel needle. Note the result. (See figure 6)

Approach the north pole of the floating magnet with the north pole of the steel needle. Note the result.

Results: Observe that when the south pole of the floating magnet is approached by the north pole of the steel needle there manifests an attraction between the two poles. This demonstrates the first law of polarity: Unlike polarities attract one another.

Also observe that when the north pole of the floating magnet is approached by the north pole of the steel needle, then the two poles tend to move apart. This proves the second law of polarity: Like polarities repel one another.

Questions: 1. What should occur if the north pole of the floating magnet is approached by the south pole of the other steel needle?

Experiment No. 8 (Continued)

2. Verify your conclusion by the proper experiment.

Experiment No. 9

The purpose of this experiment is to find the north and the south pole of the horseshoe magnet, using the law of polarities.

Materials: Magnetized steel needle, properly labelled, floating within a bowl of water (Magnetoscope of experiment 6). Horseshoe magnet (D). Pen and ink.

Procedure: Set up the magnetoscope, as described in experiment 6. Take the horseshoe magnet and approach the north pole of the floating magnet with one of the poles of the horseshoe magnet.

Observe whether an attraction occurs, or whether there manifests a repulsion.

Results: If there occurs an attraction, then the pole of the horseshoe magnet under consideration is a south pole. If a repulsion occurs then the pole of the horseshoe magnet is a north pole. Write the name of the proper polarity with ink upon each pole of the horseshoe magnet.

Repeat the experiment, using the other pole of the horseshoe magnet.

Experiment No. 10

To show that when a magnet is broken into two parts, then each part becomes a complete magnet, having two opposite poles.

Materials: Unmagnetized steel needle (E). Paper with iron filings (B). Horseshoe magnet (D). Floating magnet of experiment 6. (Magnetoscope).

Procedure: Magnetize the steel needle by the method of frictional contact of experiment 4.

Locate its north and south poles by means of the method of experiment 9.

Verify that it possesses a neutral region in the center by dipping it into the iron filings on the paper. Iron filings will be found to cling to the ends of the needle but not to the middle.

Now carefully break the needle into two parts. Place both halves of the needle into the iron filings and note that each half now possesses two poles.

Determine the nature of each of the four poles by means of the method of experiment 9.