Magnetic Relaxation - Experiment

Introduction

Some objects like refrigerator magnets are magnetic all the time. These types of magnets are called permanent magnets. Other objects only become magnetic when a permanent magnet is brought near it. These objects (e.g. nails, paper clips, staples, etc.) are called temporary magnets. When the temporary magnet is removed from the field of the permanent magnet, the temporary magnet is said to relax or loose its magnetism. Relaxation does not necessarily happen immediately or completely.

A compass is a device that tells us what direction is North. It does this by aligning a small magnet, the compass needle, with the magnetic field of the earth. The compass can be used to detect more than just the magnetic field of the Earth. In fact, it points in the direction of the strongest magnetic field in the area. If you bring a permanent near a compass and move it around, the compass will react to this magnet. In this experiment, we will be using a compass to study the rate at which a temporary magnet relaxes.

Tools & Materials:

- 1.5 Volt Battery
- 1 m of 22 gauge wire
- Magnetic Compass
- A sheet of 8 1/2 "x 11" paper
- metric ruler with millimeters
- A pencil
- A timer that can measure in 20minute increments
- An unfolded paperclip with a piece of tape marking one end
- Wire strippers
- A chart like the one below to record your results
- A permanent magnet such as a refrigerator magnet
- or a bar magnet
- Tape

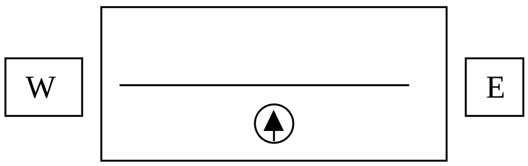
Time (minutes)	Distance From North Marking (cm)
0	
20	
40	
60	
80	
100	

The Experiment:

Before you get started, you might want to make sure your compass needle is freely rotating. To do this, hold the permanent magnet several inches directly above the north end of the compass. Slowly move the permanent magnet in a circle above the compass. The needle of the compass should freely move around in a circle without getting stuck. Once you have tested the compass, remove the permanent magnet from the experiment area.

Here's what to do:

1. Place the compass on a flat surface.
2. Wait until the compass needle stops moving around. The compass in now pointing towards magnetic north.
3. Turn the base of the compass slowly (the needle shouldn't move) so that the north marking on the compass is directly beneath the north arm of the compass needle.
4. Gently pick up the compass and place the piece of paper under it.
5. Set the compass down at the bottom edge of the paper so that the needle points toward the top of the paper.
6. Draw a line across the paper 1 - 2cm above the compass, parallel with the bottom edge of the paper. See the Diagram below.



7. Tape the paper into position. Do not move the compass from this point on (you may even want to tape the compass down.
8. Make a tick mark on the line indicating where the compass needle is pointing. Label this point N for North.
9. Build an electromagnet out of a paper clip as described in the accompanying sheet.
10. Slide the paperclip out of its wire covering. Do not uncoil the wire. (You can easily slide other paperclips in at a later time if necessary).
11. Hold the paperclip on the westernmost edge of the paper so that the paperclip is pointing straight up out if the paper.
12. Slowly move the paperclip toward the east above the line you drew on the paper. As the paperclip gets closer to the compass, you will notice that the compass should move towards the paperclip (i.e. begins pointing towards the west). If the needle is repelled to the east, flip the nail over and go back to step 9.
13. Make a tick-mark on the line indicating the position of the paperclip when the compass needle is pointing halfway between N and NW (NNW). Label this point 0 (for the 0 hour time interval).
14. Set the timer for 20 minutes and start it.
15. Measure the distance between the 0 point and the N point to the closest millimeter. Record this distance in the data table under the column "Distance From North Marking".
16. Place the nail in an isolated location (i.e. not near any permanent magnets) until needed for the next data point.
17. Make sure the compass needle has realigned with magnetic North. You may need to tap the compass several times to make this happen.
18. Repeat steps 11 through 17 every 20 minutes for the next 100 minutes. Label each mark with the elapsed time since the 0 data point.

Follow-up Discussion:

- You should discover that as time passes, the distance to the North marking decreases. This shows that to achieve the same magnetic field strength as the paperclip started with, you must bring it closer to the compass.
- When trying this same experiment with other paperclips, I discovered that although the rate of relaxation varied considerably, the paperclips never completely lost their magnetization (even after a week).