Name:_____ **Date:**_____

Partners:_____
_____
_____

Purpose:

To investigate the magnetic properties of common materials, to see magnetic lines of force by using iron filings and a variety of magnets, to make a basic electromagnet from common household materials and to build a "Gauss Cannon"

Materials:

1. Bar magnet and Horseshoe magnets
2. Sheets of loose-leaf paper
3. Iron filings
4. Paperclips and Iron rod
5. 7 Steel ball bearings
6. Magnetic compass
7. 6 rare-earth magnets
8. Wooden ruler with center groove
9. Tape
10. Large nail (approx 10 cm long)
11. 4 AA batteries, and holder
12. 45-60cm of insulated wire

NOTE: Do not place magnets on or near your laptop, USB keychain, debit or credit cards, or you will risk losing your data.

Part 1 – Basics of Magnetic Poles:

1. Take the magnetic compass, and align it so the dial points north. Now, move one end of the bar magnet towards the compass. What happens to the compass needle? What happens when you move the other end of the bar magnet towards the compass? Record your observations:

2. Repeat for a horseshoe magnet. What do you observe?

3. Try moving one of the poles of the bar magnet near one of the ends of the horseshoe magnet. Which combinations of poles " stick" to each other? Which poles push away? Are magnetic poles similar to electric charges in terms of the forces they exert on each other?

4. Take the iron rod, and bring it near the compass. What do you observe?

5. Now attach the North pole of the bar magnet against it, in the same direction, for 30 seconds. What happens now when you move the iron rod up to the compass? Can you explain what has happened?

6. Are all metals magnetic? How do you know?

Part 2 – Observing Magnetic Field Lines:

1. Place the bar magnet flat on the table
2. Place a piece of paper on top of the magnet
3. Sprinkle iron filings evenly on the paper or the cardboard
4. Tap the paper lightly
5. Sketch the patterns created by the iron filings in the space below.
6. Remove the iron filings by pouring them *carefully* back into the container.
7. Repeat steps 2-6 with someone holding a horseshoe magnet upright so its two ends are "standing" on the paper.

Observations:

1. Sketch your results below. Label the poles for the bar & horseshoe magnets.

2. The patterns you're seeing are actually the magnetic lines of force. What is significant about where these lines begin and end?

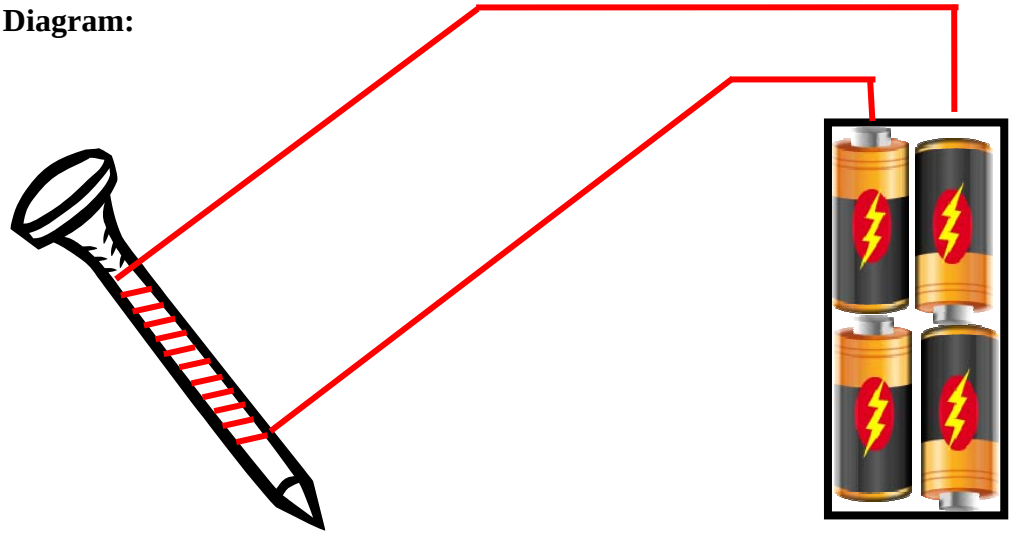
3. Where do the filings seem to stand on end?

4. Indicate on your sketch the location where the iron filings feel equal attraction from both poles. Do the lines have a particular structure at this location?

5. Does the strength of the magnet have any effect on the magnetic lines of force?

Part 3 – Making a simple Electromagnet:

Diagram:



Procedure:

1. Test to see if the nail is magnetic by trying to pick up some paper clips or similar small objects that are picked up by the bar magnet. What do you observe?

2. Wrap the nail at least 10 times with the piece of shielded wire.
3. Connect one end of the wire to one of the terminals of the battery holder. Connect the other end of wire to the other terminal of the battery holder to complete the circuit.
4. **Don't leave the circuit connected for too long, because it will get very hot!**
5. Test now to see if the nail is magnetic by trying to pick up some paper clips. What do you observe?

Questions:

1. How many paperclips were you able to pick up?

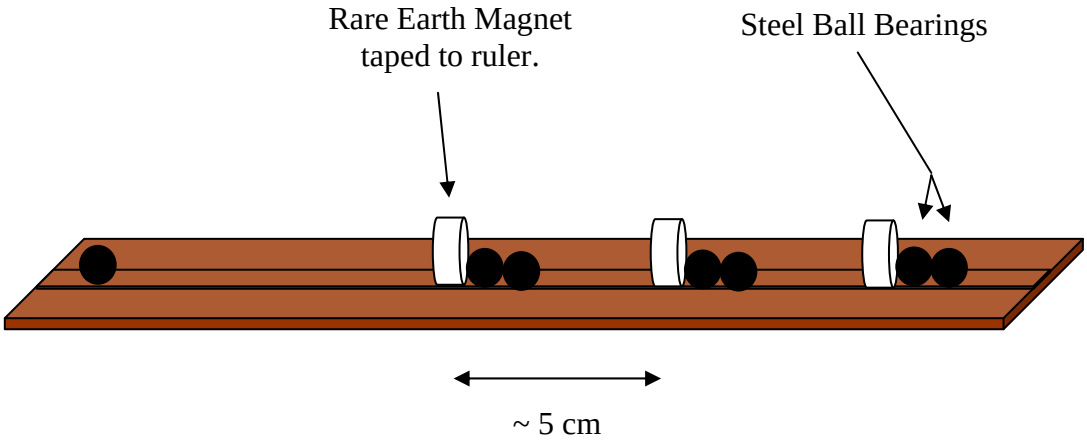
2. How many paperclips can you pick up if you increase the current flowing through the wire coil? Connect a second battery holder to the circuit, in series with the first battery holder. Write your observations below.

3. Remove the 2nd battery holder so you are back to your original configuration. How many paperclips do you think you'll pick up if you double the amount of turns of wire on the nail? Try it, and write your observations below.

4. Can you make an electromagnet by wrapping coils of wire around a pen or pencil instead of a nail? Why or why not?

Part 4 – Making a Gauss Cannon:

Diagram:



Predict!

What does the Gauss rifle actually do? Study the diagram above and see if you can describe what this apparatus does, and how it works.

Observe!

1. Tape the magnets onto the ruler as shown in the diagram. The magnets should be spaced at least 5 cm apart.

2. Place 2 bearings on the right side of each magnet.

3. Place another bearing to the left of the first magnet, as shown in the diagram. Roll it towards the first magnet, and watch what happens. *Safety note: make sure the ruler is not pointed directly at anyone.*

Questions:

1. Did you correctly predict what would happen? Describe what you observed:

2. Where does the kinetic energy of the final bearing come from? It seems to go faster than the original ball bearing. Are we getting something for nothing? In other words, have we just violated the law of conservation of energy? Explain.

3. The name “Gauss rifle” is a reference to Carl Friederich Gauss, who formulated mathematical descriptions of the electromagnetic effect used by *magnetic accelerators.* Can you think of any practical use for magnetic accelerators?

Summary and Suggestions for the Future:

a. What were the important concepts of physics/science that you learned from this activity? What else did you learn?

b. Can you think of alternative hands-on ways in which these concepts could be demonstrated?

c. What changes (if any) would you make to teach these activities in a Grade 7-8 classroom