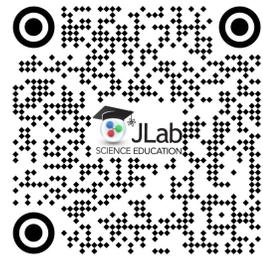


Name: \_\_\_\_\_



# ***Magnets and Electromagnets***

**CAN YOU MAKE A MAGNET FROM A NAIL,  
SOME BATTERIES AND SOME WIRE?**

## ***Problem***

**Can the strength of an electromagnet be changed by changing the voltage of the power source?**

## ***Research***

**Answer the following True or False questions about magnets and electromagnets:**

True/False Heating or hitting a permanent magnet can ruin it.

True/False Iron is a good metal to use to make an electromagnet.

True/False The north pole of one magnet will attract the north pole of another magnet.

True/False Magnets and electromagnets are used in many devices.

## ***Hypothesis***

**If the voltage is increased, then the electromagnet's strength will \_\_\_\_\_ .**  
*(increase / not change / decrease)*

# Procedure

## How to make the electromagnet:

1. To make an electromagnet, you will need:
  - A length of wire
  - A nail
2. Take the wire and straighten it.
3. One end of the wire has a clip attached. Hold the clip in your hand and measure off an arm's length of wire. This splits the wire into two sections, one much longer than the other.
4. Take the **long** section of wire and wrap it neatly around the nail. Start wrapping at the flat part of the nail and work your way towards the nail's point.
5. Wrap the wire neatly around the nail. The more turns of wire you use, the stronger your electromagnet will be!

## How to use the electromagnet:

1. To test your electromagnet you will need:
  - A battery pack
  - Some paper clips
2. There are four different settings on the battery pack. They are labeled 1.5V, 3.0V, 4.5V and 6.0V. The "V" stands for volts. The volt is a unit used to measure electric potential. It tells you how much energy is being given to the charges that are flowing through the wire.
3. Your team will test your electromagnet by seeing how many paper clips it can pick up at each voltage. **Test each voltage two times.**
4. There are two jobs to do:
  - **Power Operator** - turns the electromagnet on and off
  - **Crane Operator** - dunks the electromagnet into the container of paper clips
5. How do you turn the electromagnet on? Both ends of the wire have to be attached to the battery pack correctly so that electricity can flow:
  - Clip one end of the wire to the screw on the battery pack labeled **TOP**
  - Hold the other end of the wire onto the metal near the voltage label that you want to test

**REMEMBER:** Metal has to touch metal for electricity to flow!  
Touch the wire to the metal screws, not to the plastic battery case!
6. Once the Power Operator has turned on the electromagnet, the Crane Operator should put the nail in the container of paper clips.

7. Gently mix the paper clips with the electromagnet.
  8. Carefully lift the electromagnet out of the paper clip container and move it to a clean spot over your desk.
  9. Turn the electromagnet off by removing the wire from the battery pack and let the paper clips fall.
  10. Count how many paper clips the electromagnet picked up and record that number on the **Electromagnets Data Chart**.
  11. Keep testing your electromagnet until you have tried each voltage twice.
  12. After you have finished testing the electromagnet, make certain that everyone on your team has all of the data.
  14. Average each voltage's tests together. If you don't remember how to average, look at the example below.
  15. Use the **Electromagnets Results Graph** to show the **average** number of paper clips the electromagnet picked up at each voltage.
- 

## HOW DO I FIND THE MEAN (AVERAGE) OF 22 AND 43?

Add up all the numbers that need to be averaged.

$$\begin{array}{r} 22 \\ + 43 \\ \hline 65 \end{array}$$

Divide by the number of numbers you added.

$$\begin{array}{r} 32.5 \\ 2 \overline{) 65.0} \\ \underline{-6} \phantom{0} \\ 05 \\ \underline{-4} \phantom{0} \\ 10 \\ \underline{-10} \\ 0 \end{array}$$

*You added two numbers together, so you divide by two. If you had added three numbers together, you would have divided by three. If you had added 1000 numbers together, you would have divided by 1000.*

# Data Collection and Analysis

## Electromagnets Data Chart

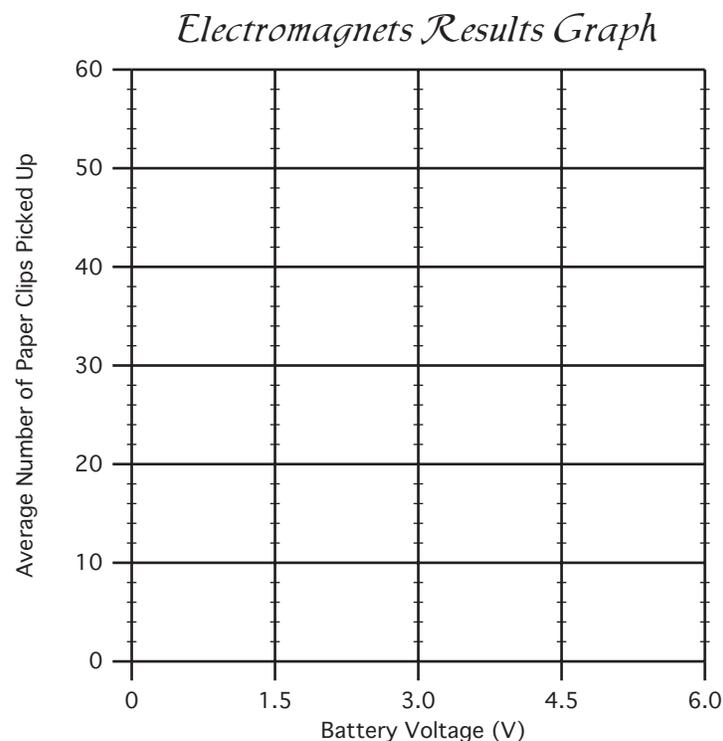
**Directions:** Record the number of paperclips picked up by the electromagnet for each try. **After** you have collected all of the data, average the number of paper clips picked up at each voltage.

### Paper Clips Lifted by the Electromagnet

Battery Voltage	Number of paper clips picked up		Mean = $\frac{(1^{\text{st}} + 2^{\text{nd}})}{2}$ (Average)
	First try	Second try	
1.5V			
3.0V			
4.5V			
6.0V			

LET'S MAKE A GRAPH!

**Directions:** Make a **line graph** showing the **average number of paper clips** the electromagnet picked up for each voltage tested.



## NAME THAT VARIABLE!!

**Directions:** Identify the **Independent Variable**, **Dependent Variable**, **Constants** and **Control** of this experiment.

<b>Independent Variable</b>	
<b>Dependent Variable</b>	
<b>Constants</b>	
<b>Control</b>	

## Conclusion

INCREASING THE VOLTAGE APPLIED TO AN ELECTROMAGNET  
\_\_\_\_\_ ITS STRENGTH.

## QUESTIONS TO THINK ABOUT

1. What happened to the strength of the electromagnet when more volts were used?
2. How are electromagnets used at Jefferson Lab?
3. Where can you find electromagnets in your home?
4. How can you make a permanent magnet lose its magnetism?