

What you need: A length of copper wire, a nail, batteries, paper clips

## HOW TO MAKE AN ELECTROMAGNET

- 1 Take the wire and straighten it.
- 2 Hold the one end of the wire in your hand and measure off about the length of your hand. This splits the wire into two sections, one will be much longer than the other.
- 3 Take the long piece of wire and wind it neatly around the nail. Start winding at the flat part of the nail and work your way towards the nail's point. 
- 4 Wind the wire around the nail 6 times to build the first electromagnet. Make sure you wind the wire all in the same direction. See how many paperclips you can pick up.

By the end of the workshop you will have wrapped the wire around the nail at least 30 times.

## HOW TO USE THE ELECTROMAGNET

- 1 Have a look at the batteries on the table. They are labeled 1.5V. The "V" stands for volts. A volt is a unit used to measure the strength of the force that pushes the electricity out of the battery, like meters is a unit used to measure the length of something.
- 2 You will test your electromagnet by seeing how many paper clips it can pick up at each set of turns.
- 3 There are two jobs to do:
  - ✓ Power Operation : turns the electromagnet on and off;
  - ✓ Crane Operation : dunk the electromagnet into the container of paper clips.
- 4 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: 



- ✓ Attach one end of the wire to the + end of the battery.
  - ✓ Attach the other end of the wire to the - end of the battery.
- Remember: metal has to touch metal for electricity to flow.**

- 5 Once the power operation has turned on the electromagnet, the crane operation should dip the nail into the container of paper clips. Gently mix the paper clips with the electromagnet, carefully lift the electromagnet out of the paper clip container and move it to a clean spot on the desk. 
- 6 Turn off the electromagnet by removing the wire from the battery and let the paper clips fall.

- 7 Count how many paper clips the electromagnet picked up and record the number on the **Electromagnets Data Chart** at the back of this sheet.
- 8 Wrap the wire around the nail another 6 times. (There should be 12 turns on the nail now). See how many paper clips you can pick up now. Always wrap the wire in the same direction.
- 9 Wrap the wire another 6 turns around the nail. (There should be 18 turns on the nail). Count the paper clips you pick up. Keep on going in turns of 6, until you have wrapped the wire around the nail 30 times.

**Sneaky Tip**  
Instead of dunking the nail into the paper clips, try gently touching them onto the nail instead. See how many you can attach this way.

## Questions to think about.

1. What happened to the strength of the electromagnet when more turns of wire were used?  
.....
2. How are electromagnets used at iThemba LABS?  
.....
3. Where can you find electromagnets in your home?  
.....
4. How can you make a permanent magnet lose its magnetism?  
.....
5. Do you pick up more or less paperclips when the wires connecting the battery are swapped? Is there any difference?  
.....

# Data Collection & Analysis

Record the number of paperclips picked up by each electromagnet for each try. After you have collected all of the data for all 5 of the electromagnets, average the number of paper clips picked up at each voltage.

No of turns of wire on the nail	Number of paper clips picked up		Average = $\frac{(1^{st} + 2^{nd})}{2}$
	First try	Second try	
6			
12			
18			
24			
30			

Identify the Independent Variables, Dependent Variable, Constant and Control of this experiment.

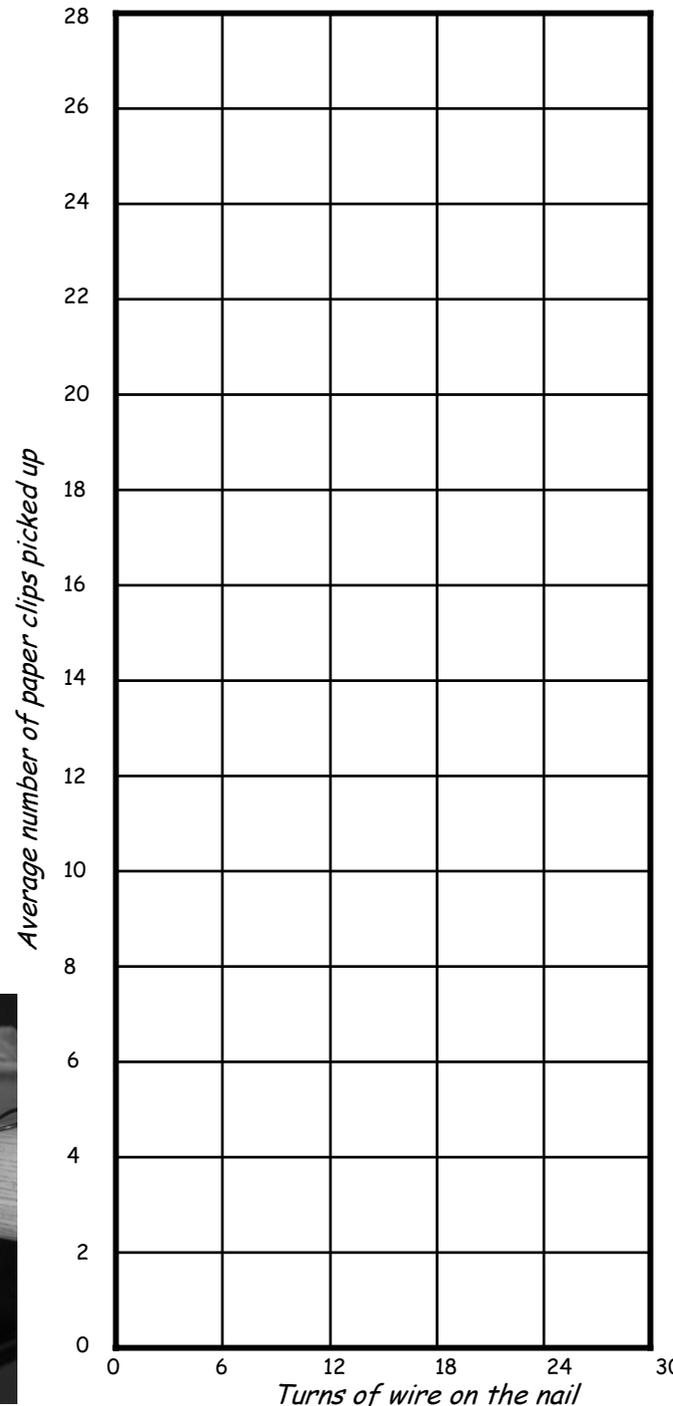
Independent Variable	
Dependent Variable	
Constants	
Control	

## Name that Variable

Now... have some extra fun and see just how many screws, nuts and washers (and whatever else) you can pick up with your electromagnet / magnet.



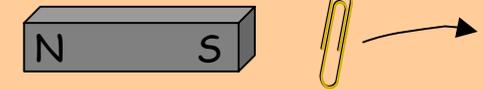
## Electromagnets Results Graph



Show the average number of paper clips each electromagnet picked up for each series of turns. Use the averages you calculated on the Electromagnets Data Chart to make a line graph for each strength of the electromagnet.

## MAKE YOUR OWN MAGNET

Here's what you'll need to make a new magnet with another magnet: magnet & paper clip



First, straighten out the paperclip.

Then rub the south end of the magnet down the *lower* half of the paperclip. Push firmly. Repeat this about 50 to 75 times.

Reverse the magnet and the paperclip, and rub the north end of the magnet down the upper half of the paperclip. Repeat this also about 50 to 75 times.

*You are pulling all the particles that make up the paperclip in the same direction. All their north poles will point in one direction, and all their south poles in the other.*

Now the straightened paperclip will be a magnet too. Try lifting some more paperclips.

You can use a compass needle to decide which end of your paperclip magnet is north, and which is south, and mark the ends with paint.

Do you think it's possible to cut this magnet in half, and make one magnet with just a north pole, and one with just a south pole?