Strengths of Different Electromagnets

Reading

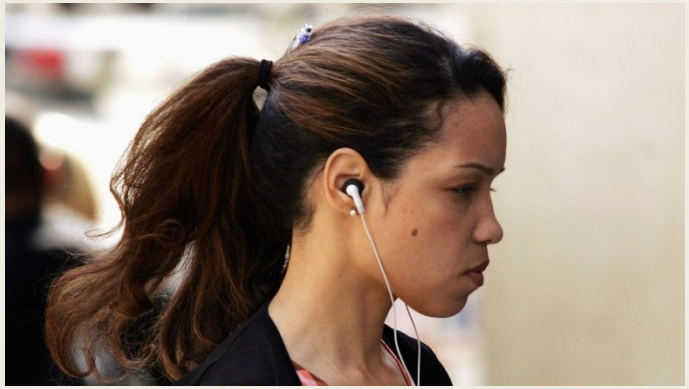
I heard there are magnets that can be turned on and off. They are called electromagnets, and they can be little or big. Some can pick up thousands of pounds of metal. They are made by running electricity through wires, which creates a magnetic field around the wire. Putting metal next to the wire will make the metal into a magnet for as long as electricity is running.

There are many uses of electromagnets in everyday life, such as locks on car doors, electric motors, ear buds for listening to music, even high-speed trains that rise up off the tracks and travel on air. These magnets are everywhere.

Electromagnetism was discovered in the nineteenth century and studied by a scientist named Michael Faraday in England.

https://en.wikipedia.org/wiki/Electromagnetism

Examples of electromagnets in use



Ear buds for music

Lifting tons of scrap metal

Old-fashioned alarm bell

Very fast high speed Maglev Train

Question and Hypothesis

Question: If you make electromagnets out of loops of wire wound around a steel bolt, how does the strength of the magnet depend on the number of loops of wire?

Hypothesis: I think the strength of the magnet will be greater if there are more loops of wire around the bolt. I will make bolts with one, two, and three layers of loops and measure their strength by picking up metal paper clips.

Variables

Independent Variable – The one thing I changed was the number of layers of wire loops. Each layer will have 40 loops.

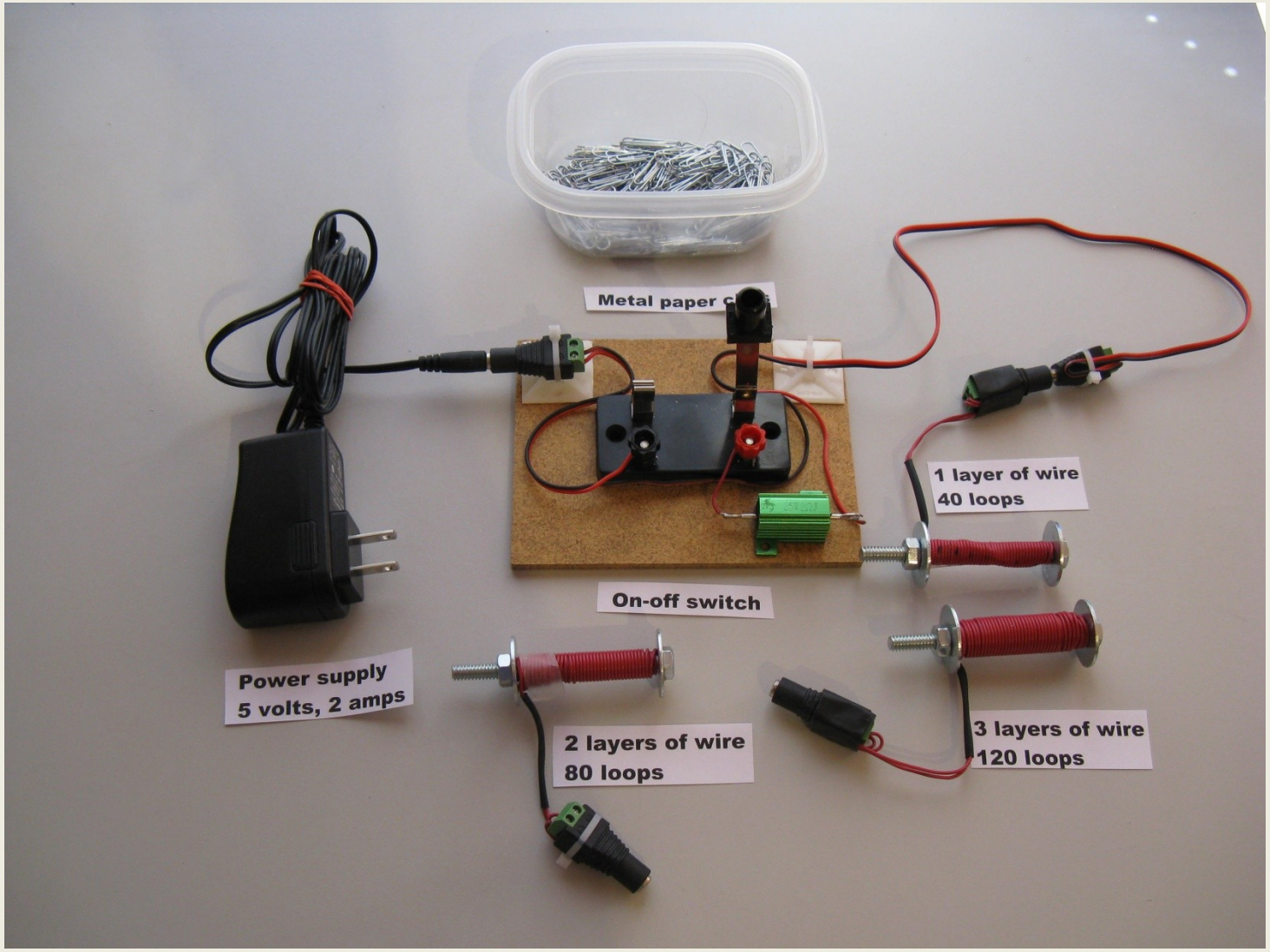
Dependent Variable – I measured the number of paper clips picked up by the magnet each time.

Controls – (1) the power supply is constant; (2) the bolt lengths are identical; (3) wire loops are all made with the same kind of wire; (4) the paper clips are identical and in a large pile in a container; (5) the same person does all the trials.

Materials

1. Power supply
2. Three metal bolts wrapped with 40, 80, or 120 loops of wire in one, two, or three layers
3. Paper clips
4. Apparatus with an on/off switch to provide electricity to the magnets
5. Cups to collect the paper clips before counting
6. Data sheet for recording my results

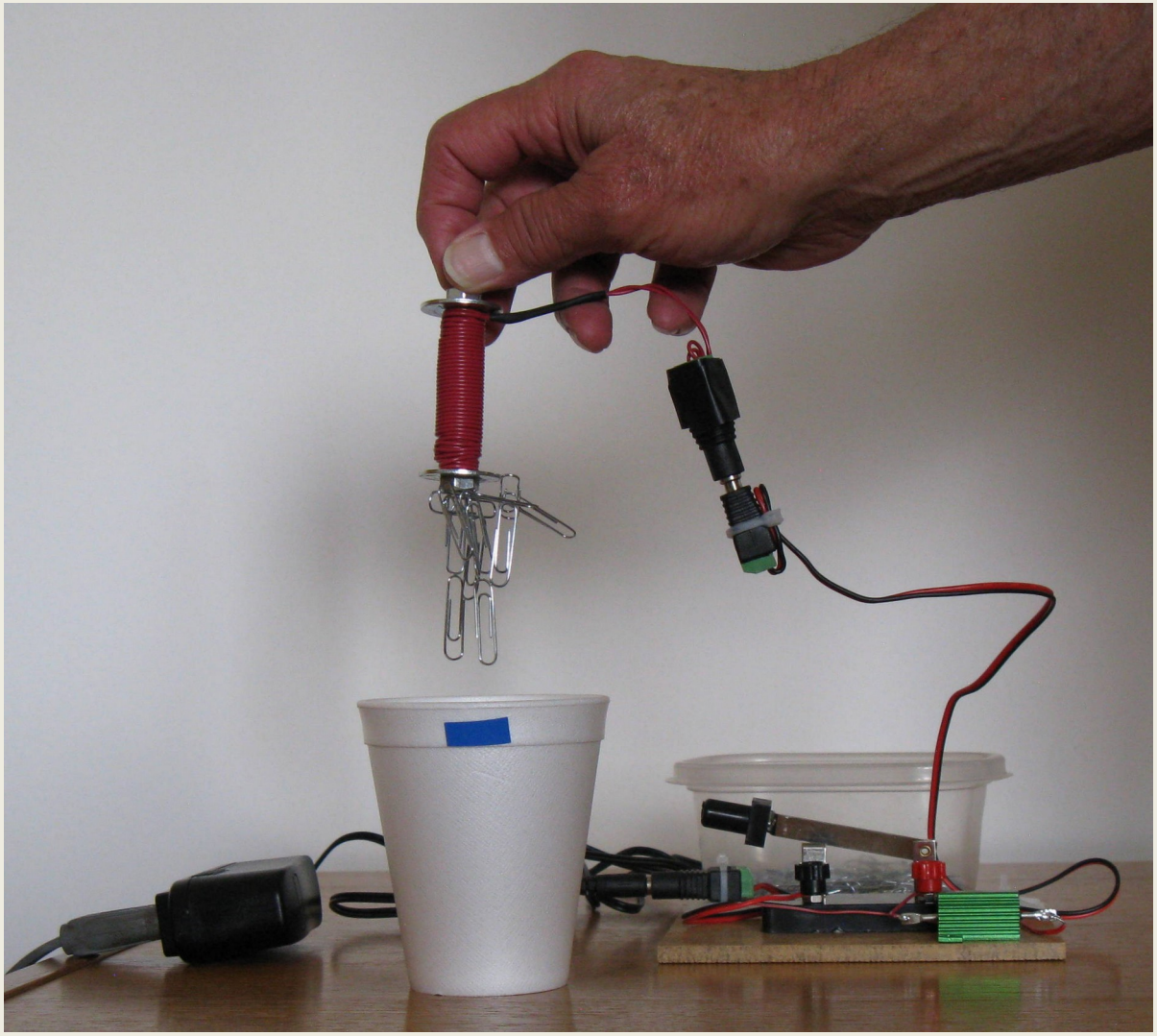
The experimental equipment



Procedure

1. Have a bowl with many more paper clips than you expect to need
2. Connect the power supply to the switch device. Make sure the circuit is “open,” so the knife switch is vertical. Attach the one-layer bolt to the switch device.
3. Arrange five numbered, colored cups in front of the switch device.
4. Pick up the wire-wrapped bold with the flat head down. Close the switch to allow electricity to flow through the wires.
5. Touch the flat head of the bolt to the pile of paper clips. Pick up the bolt and attached clips and move it carefully to the first cup.
6. Open the switch. The clips will fall into the cup. Repeat the process four times so that all five cups have clips in them from each of the five trials.
7. Repeat the process with the two-layer, then the three-layer magnets.
8. Count the number of clips in each cup and enter the number on the data sheet.
9. Do not leave a bolt connected to power for any longer than necessary; it will heat up and become dangerous.

Performing the Experiment



Data Sheet for Magnetism Experiment

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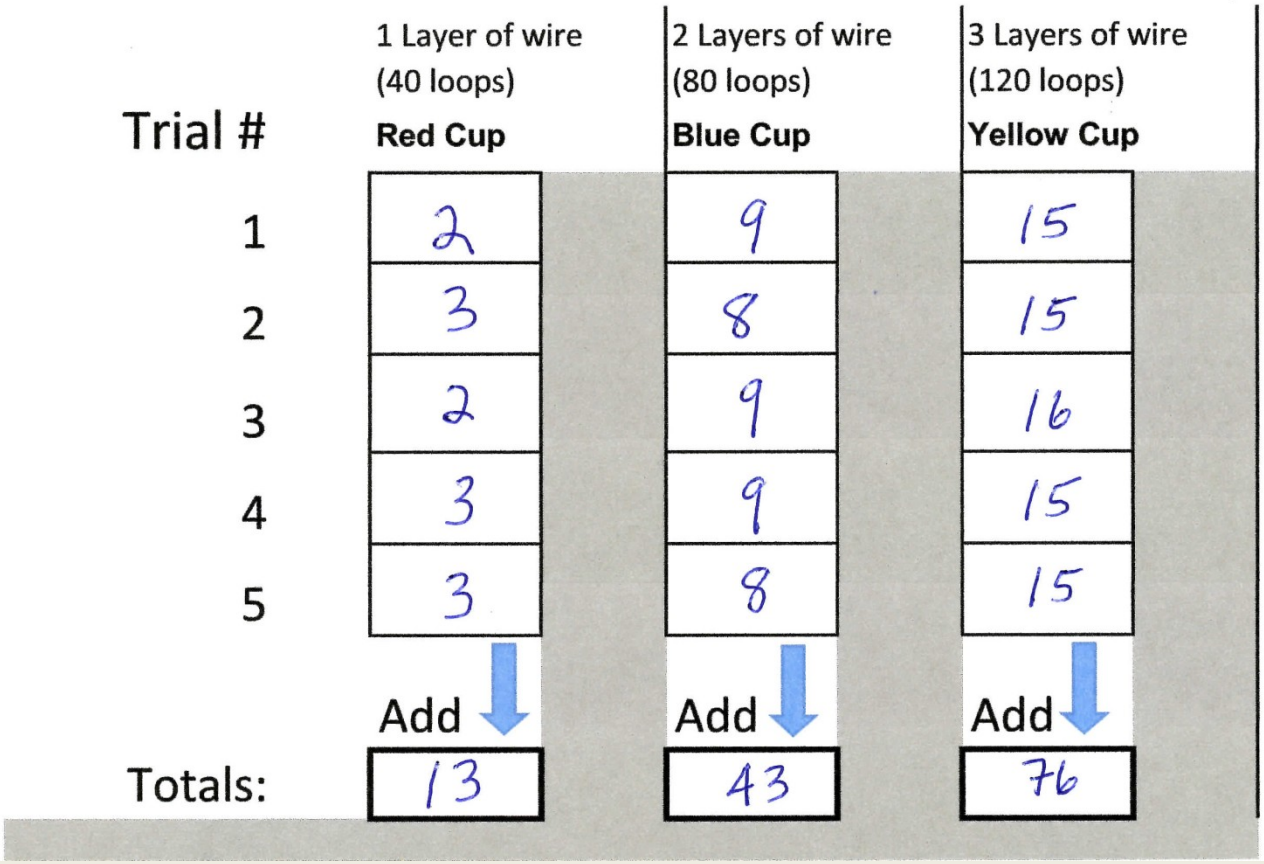
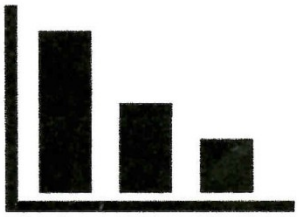
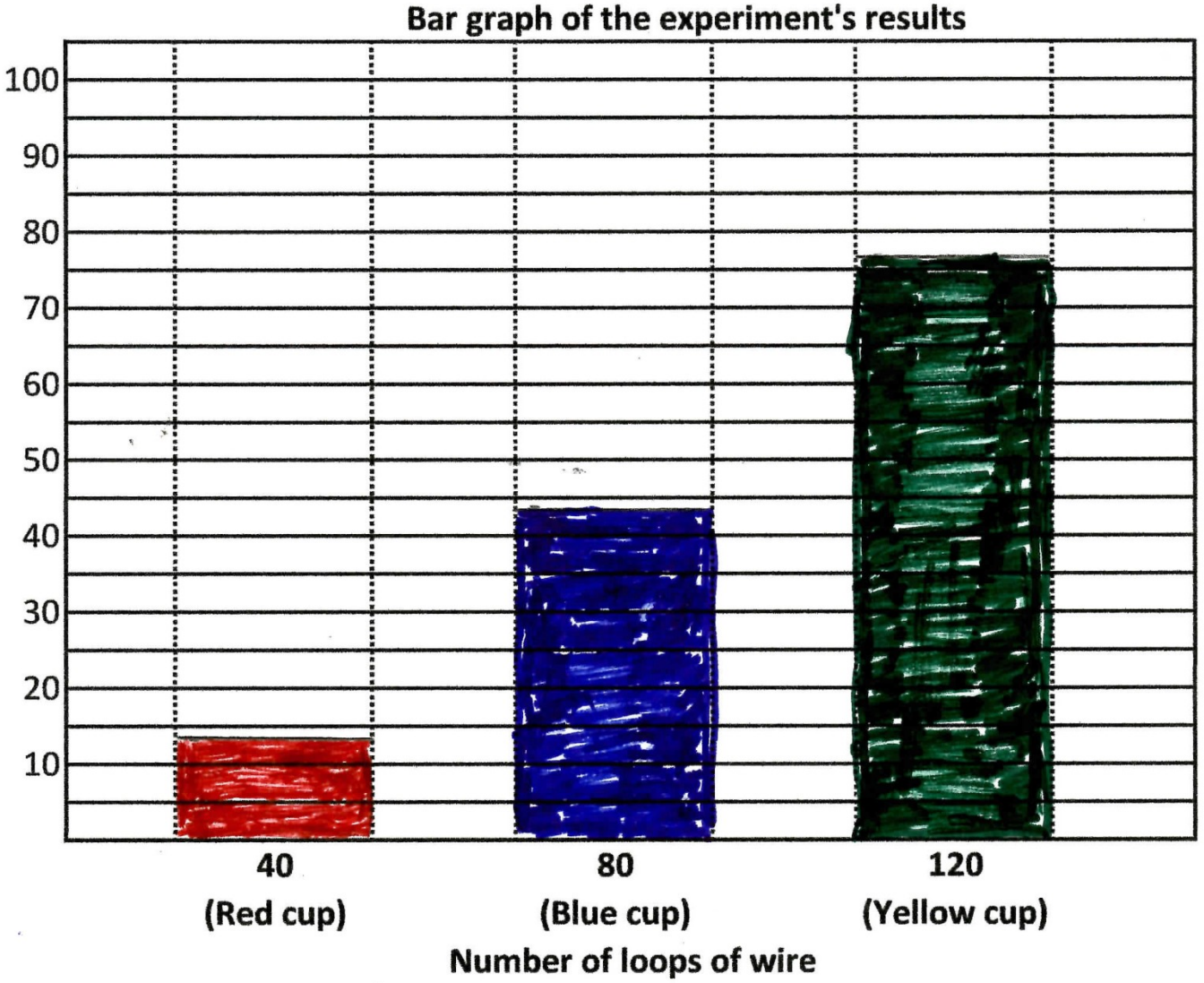




Total number of paper clips picked up in five trials



Conclusion

My hypothesis was correct. The bolts with more layers of looped wire picked up more paper clips, so the magnets were stronger. Results of individual trials were very consistent, so I think that the measurements were accurate.

If I did the experiment again. . .

I would use bolts with more layers, at least four or five. I want to know if the strength of the magnet increases by the same amount with each added layer, or if it increases by less or more each time.

I would also try to measure strength of magnets where there was only one layer of wire loops, but there are more loops over a longer distance on the bolts (so the bolts would be longer than the ones used here). They could have 40, 80, and 120 loops, but only in one layer.