STEM 101
Powered by THE STEM ACADEMY

Name: _____
Period: _____

UNIT: MEASUREMENT

"FIELD FORCES" – ELECTROMAGNETIC ARM ASSIST

OBJECTIVE:

Investigate how electric or magnetic fields interact with objects.

GOAL:

You will build a simple electromagnet, explore how well it can lift or move magnetic objects, and measure its electrical properties using a multimeter. Then, you'll reflect on how electromagnets could help move parts in a robotic arm.

MATERIALS:

- ✓ Iron nail (3–4 inches)
- ✓ Insulated copper wire (about 3 feet)
- ✓ AA battery (or 9V battery for stronger field)
- ✓ Electrical tape or alligator clips
- ✓ Paperclips, small metal objects
- ✓ Compass (optional)
- ✓ Multimeter (for voltage and resistance)

STUDENT DIRECTIONS:

Step 1: Build Your Electromagnet

1. **Wrap the Wire**
   - Tightly coil the wire around the nail, leaving about 3 inches of wire free on each end.
   - Try to make the coils neat and close together (this increases the strength).
2. **Connect to Power**
   - Tape one wire end to the positive (+) terminal of the battery.
   - Quickly touch and hold the other wire end to the negative (–) terminal.
   - ⚠️ **Only connect for short intervals (10–15 seconds)** to prevent the wire from overheating!
3. **Test It**
   - Try to pick up paperclips or attract small metal objects.

- Move a compass near your electromagnet—does the needle react?

Step 2: Measure the Electromagnetic Properties

1. **Voltage Across Your Coil**
   - Set your multimeter to DC Voltage (V⎓).
   - Connect probes to both wire ends *while connected to the battery*.
   - Record the voltage:
     - Coil Voltage: _____ V
2. **Resistance of the Coil**
   - Disconnect the battery.
   - Set the multimeter to resistance (Ω).
   - Connect probes to each wire end of the coil.
   - Record resistance:
     - Coil Resistance: _____ Ω

Engineering Reflection:

- What variables seemed to make your electromagnet stronger?

  _____

  _____
- How could a robotic arm use this kind of electromagnetic system to pick things up?

  _____

  _____
- What might limit how strong your electromagnet can be?

  _____

  _____

Extension Challenge (Optional):

Can you increase the strength of your magnet by:

- Adding more coils?
- Using a larger nail?
- Using more batteries?

Test and compare results—record your changes and findings below.

STANDARDS ALIGNMENT

NGSS: HS-PS3-5 **STEL:** STEL 1E, STEL 2E, STEL 7F, STEL 8F, STEL 11F **CCSS:** CCSS.MATH.CONTENT.HSN.Q.A.1, CCSS.MATH.CONTENT.HSN.Q.A.3, CCSS.MATH.CONTENT.HSF.IF.C.7, CCSS.MATH.PRACTICE.MP2, CCSS.MATH.PRACTICE.MP5