

Lab 5: Lorentz Force Student Handout

The Project: Lorentz Force

Company X has been contracted to develop a detector to permanently install on the International Space Station (ISS). ISS regulations require that the device be small in size in order to integrate seamlessly with the surrounding equipment. This device will use a series of circuits combined with a number of neodymium magnets to monitor charged particles that have been ejected from solar flares. A NASA scientist has expressed concern that the force exerted on the circuit from the magnets. You have been hired to help characterize the forces that will be exerted on the circuit from the magnets of the detector.

Equipment Available to You:

- DC Power Supply
- Neodymium Magnets
- Data Acquisition (DAQ) Unit
- BNC to Alligator Cable
- Banana to Alligator Cables
- Detector Magnet Holder
- PASCO Field Coil
- Strain Gauges
- PASCO Weight set

Possible Needed Techniques:

- Measuring Voltage with a DAQ
- Basic Circuit Design
- Basic Python Commands

Pre-Lab Organizational Questions:

1. Strain gauges convert an applied force into a voltage that can be read using the DAQ. What procedure can you use to convert the measured voltage to the applied force?
2. Your power supply can operate as a voltage supply or a current supply. Which setting would be the most useful for your measurement? What quantity should be your independent parameter?
3. The magnetic field of the magnet is unknown. What experiment can you do to quantify the magnetic field on the circuit.

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The Requirements:

We ask that you characterize the behavior of circuit under the influence of a magnetic field. Please provide:

1. The equation that you used to convert the voltage on the strain gauges to the applied force
2. The magnetic field strength acting on the wires of the circuit. You need to include any error/uncertainty in that measurement.
3. The relationship between the current in the circuit and the force applied on the circuit.

Presentation of the solution:

Your team must prepare a presentation that will be given to a member of Company X on the approach that your team is using to complete the project. The presentation may be given by the whole team as a group or by a single member of the team chosen by a member of Company X. The presentation must include:

- A description of the basic physics principles used in your project.
- Plot of the data used to convert the voltage reading on the strain gauges to applied force. Include all raw data that you used to create this plot.
- A figure and description that describes your experimental design to probe the relationship between current and force
- Plot the relationship between the current through the circuit and the force applied on the wire. Include all raw data. Be sure to comment on the direction of the force acting on the circuit.
- The value of the net magnetic field produced by the magnet on the circuit. Include the uncertainty in this measurement.