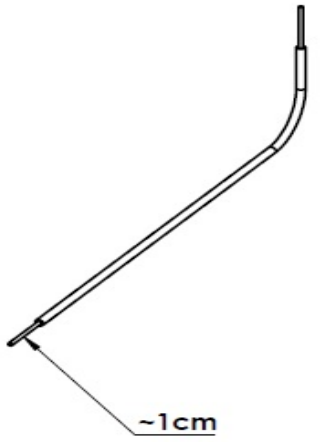
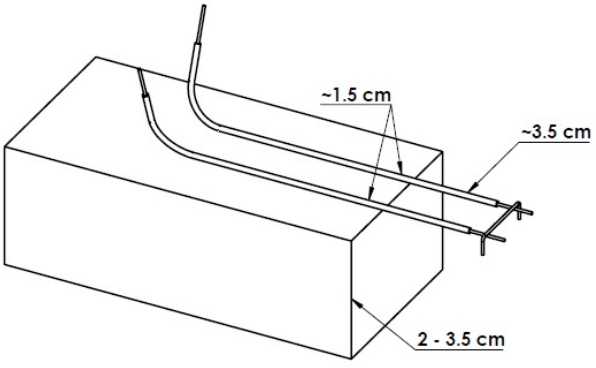
Experiment 20210316

Measuring magnetic field strength by estimating the force on a current carrying wire

1. Take two lengths of wire and expose equal lengths of about a 1 cm length of bare wire using a blade or a wire stripper. If you trim too much on one wire, you can trim cut off the extra wire using a pair of scissors or blade. Do not use scissors that are kept for dedicated and delicate operations. Clean the exposed wire by light scraping it with a blade or emery paper. Measure the exposed length as accurately as you can.

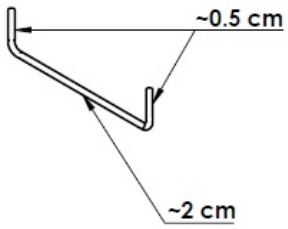


2. Find a non-magnetic box of about 2.5 to 4 cm height. Using some tape, fix the wires about 1.5 cm apart and with the tips of the wire about 3.5 cm from the edge of the box. Bend the part of the wires that are on the box upwards so that you can easily make connections to them. The exposed wire should be as horizontal. Measure the separation of the wires as accurately as you can.

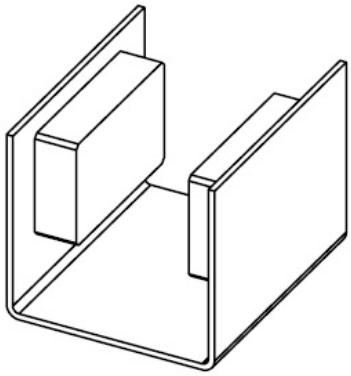


3. Cut a short length of wire of about 3 cm length and remove all the insulation from it. Measure the length of the wire as accurately as you can. Using a blade or emery paper, lightly clean it to remove any oxide that may have formed on its surface. Bend it in the

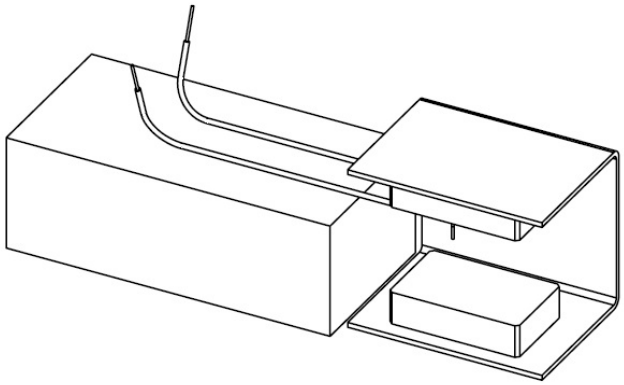
form of a right angled “U” whose base is about 2 cms long and the arms about 0.5 cms. Place this ‘bridge wire’ on the exposed part of the wires somewhere around the middle.



4. Wire up the 4-AA battery pack to drive a current through this arrangement. Wire up the multimeter so that the current can be measured through the 10 A terminals. Set the dial of the multimeter to 10A DC. Set it up so that you have a flying lead that you can use as a switch. (Connect one crocodile clip permanently and use the other one as a flying lead) Briefly close the circuit and measure the current. It should be in the neighbourhood of 2 A.
5. Set up the magnet as in the figure below with opposite poles facing each other. To do this, slowly bring the faces of the magnet together in an attracting configuration. Hold the magnets firmly while doing this and ensure that the magnets do not slam into each other. They are brittle and the impact will break them. Now slowly separate them and attach the outside faces to the yoke. Place the long sides of the magnet parallel to the base of the yoke.



6. With the circuit open, place the magnet arrangement so that the magnetic field is in the vertical direction and centered around the bridge wire.



7. Briefly close the circuit. The bridge wire will move either towards the support and hit the insulated end of the wire or in the opposite direction and fall off. If it moves towards the support, reverse the direction of the magnetic field by turning the magnet assembly around. You want to orient the field so that the bridge wire falls off away from the assembly.
8. Set the bridge wire back on the rail, this time, as close to the insulation as possible. Close the circuit. The wire will fall off some distance away from the vertical plane of the tips of the rail. Measure this distance. You can use an appropriately placed graph paper to aid the measurement. Repeat this three times and take the average as the range of this projectile. You will also need the height of the wire rail.
9. You will use a three step procedure for estimating the field.
10. The bridge wires velocity (horizontal) when it leaves the rail can be estimated from the range and the height through which it has fallen (2-D projectile).
11. Calculate the acceleration of the bridge wire from the velocity you have estimated above and the distance it has moved from rest (the length of the exposed part of the rail wire).
12. The net force is given by Newton's second law.
13. Assuming a coefficient of sliding friction between the wires to be 0.3, calculate the force due to the magnetic field. The density of the wire material is 8.7 gms/ml. The diameter of the wire is 0.51 mm.
14. Assume that the magnetic field is uniform (good assumption) and that the current is the constant value that you measured in step 4 (not entirely correct – why?), calculate the magnetic field. Estimate the error and report it to the correct number of significant figures! Be careful about the units.

Note

A photograph of your setup showing all the components clearly should be a part of your report.

Rubric

Item	Points
Performing the experiment as evidenced by the photograph	35
Photograph of setup	5
All calculations shown clearly	25
Evaluation of errors	10
Correct Units	10
Significant figures	10
Correct naming of report (yourName20210316)	5
Total	100