Online laboratory assignment 6 – Lenz's law

Purpose: to study the direction of current induced by a change in the magnetic field contained by a wire loop.

Introduction

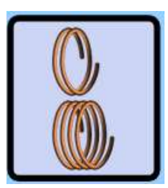
Magnetic flux is the amount of magnetic field vector passing through a given area. Faraday's Law states that a time changing magnetic flux through an area bounded by a closed circuit induces an emf that drives the flow of current around the circuit. Lenz's Law gives a quick reference to the direction of the emf in a circuit loop as explained more completely explained by Faraday's law. Lenz's law states that the polarity of the induced emf produces a current that creates a magnetic flux which opposes the external change in magnetic flux.

We can see the direction of the current induced in a solenoid from a time changing magnetic field by observing the needle of a galvanometer. A galvanometer reads a positive current when the current enters the positive (+) input terminal and leaves through the negative (–) terminal. It reads a negative current when the current enters the negative (-) terminal and leaves the positive (+) terminal.

The magnetic field lines external to a bar magnet go from the N pole to the S pole. Since magnetic field lines are continuous, that is, they do not start or end anywhere, the field lines inside the bar magnet must necessarily go from the S pole to the N pole. This situation is in contrast to electric field lines, which do begin and end at electric poles (at positive and negative charges). All the magnetic field lines outside the magnet must be squeezed together as they pass through inside, going the opposite direction. If this is confusing, draw a simple diagram of a bar magnet, and add field lines to your drawing both inside and outside the magnet, indicating the directions of the fields with arrows.

Laboratory assignment

1. Run the "Faraday's law" PhET simulation.
2. Select the two coil option.



3. Move the magnet in and out of the two-loop coil at a moderate speed.
4. Then move the magnet in and out of the four-loop coil at roughly the same speed.
5. Describe the differences in the current produced by changing the magnetic field in the two-loop coil versus the four-loop coil.

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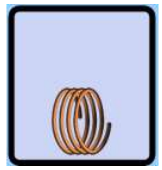
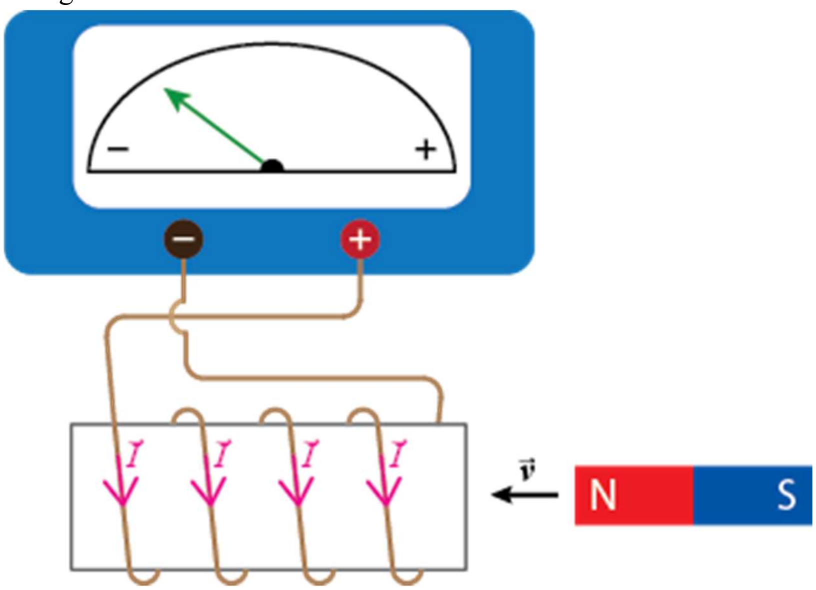
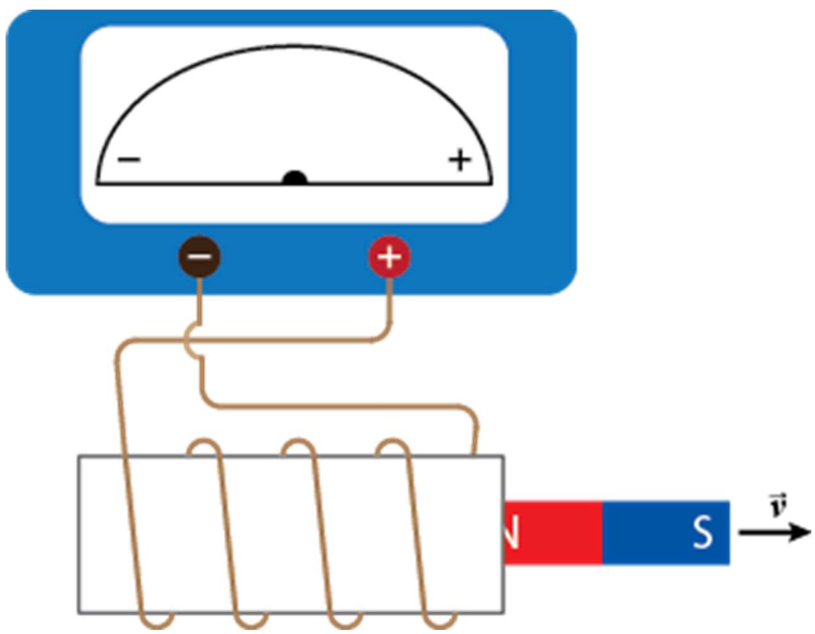
6. Select the single coil option.



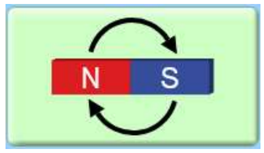
7. Begin with the north end of the magnet facing the coil while on the right and quickly move the magnet into the coil. The magnetic field increases in the left direction as the bar magnet enters the coil, which means that there is an induced magnetic field that opposes the time changing field. Thus, an induced current flows through the wire, and the right-hand-rule tells us that it flows into the negative terminal of the meter. The meter reads the current into the negative terminal and points in the negative direction as shown below.



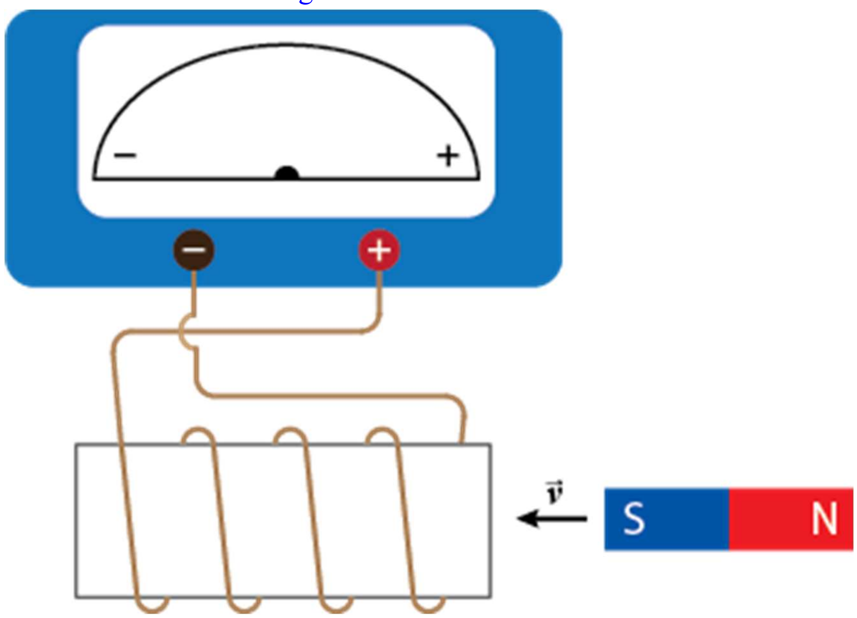
8. Next pull the magnet to the right with its north end facing left out of the coil. Use the right-hand-rule to label the direction of the current in the coil and the needle direction in the diagram below.



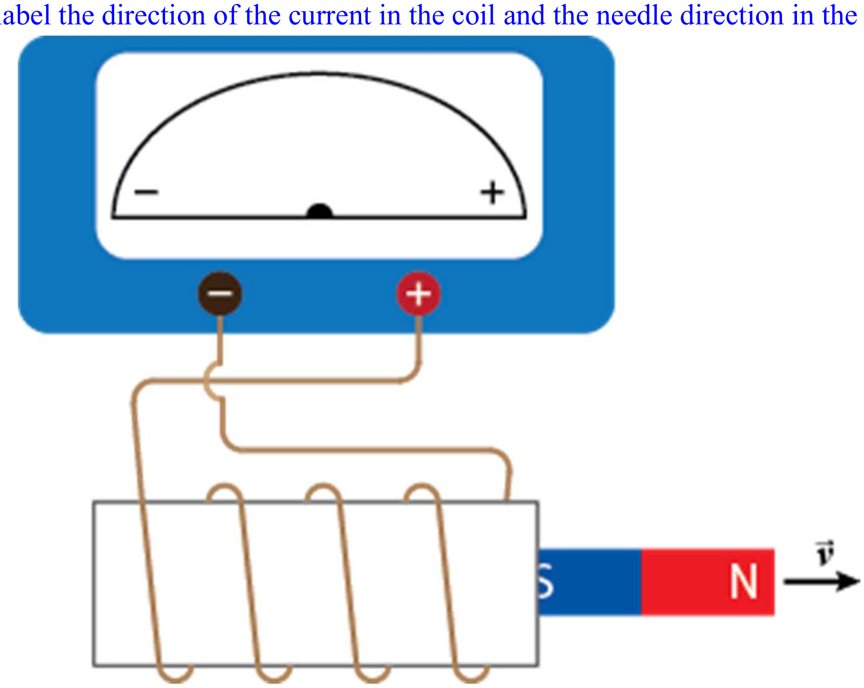
9. Select the button that flips the magnet polarity.



10. With the south end of the magnet facing the coil while on the right side of the coil, quickly move the magnet into the coil. Use the right-hand-rule to label the direction of the current in the coil and the needle direction in the diagram below.

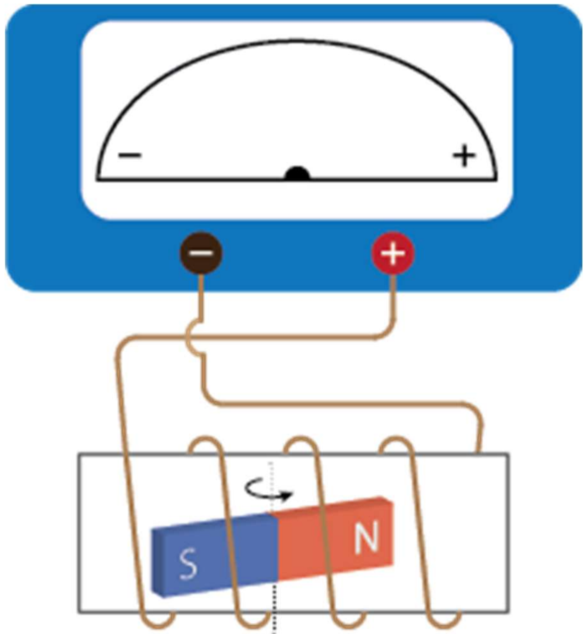


11. Next pull the magnet to the right with its south end facing left out of the coil. Use the right-hand-rule to label the direction of the current in the coil and the needle direction in the diagram below.

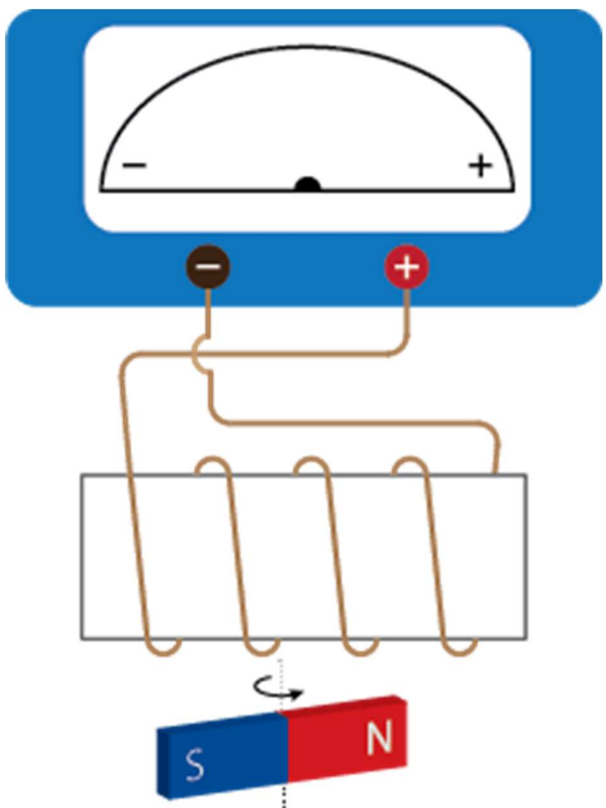


12. Begin with the magnet <u>inside</u> the coil with the south pole facing to the right. Select the flip polarity button so that the magnet turns inside the coil and the north pole faces right. Use the

right-hand-rule to label the direction of the current in the coil and the needle direction in the diagram below.



13. Begin with the magnet below the coil with the south pole facing to the right. Select the flip polarity button so that the magnet turns inside the coil and the north pole faces right. Use the right-hand-rule to label the direction of the current in the coil and the needle direction in the diagram below.



14. Write a conclusion to this laboratory assignment [the conclusion should also discuss the direction as well as the relative magnitude of the current in different cases and under different circumstances. It should also include the use of Lenz's law and/or Faraday's law in its reasoning].

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