

Background

We've already learned that a current produces a magnetic field, as described by the Biot-Savart Law and Ampère's Law. Michael Faraday, somewhat weak mathematically but a great experimenter, was the one who determined that magnetic fields, in turn, produce currents. More specifically, a *changing* magnetic flux in the vicinity of a conducting loop will produce current in that loop.

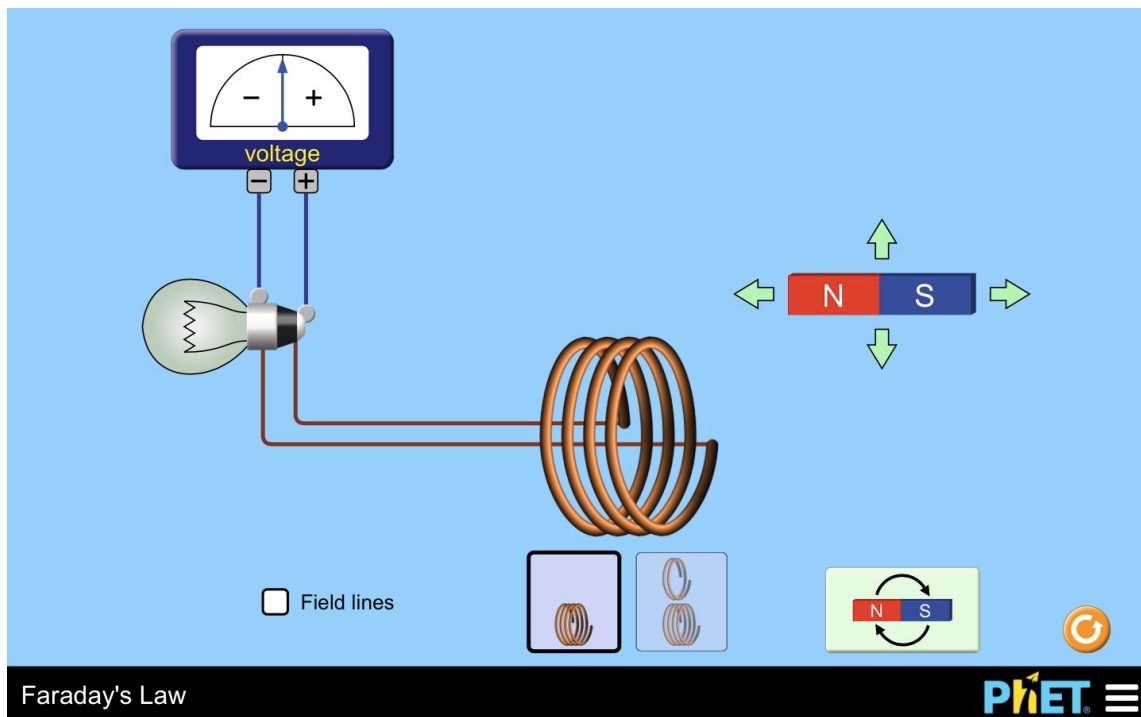
This PhET activity lets you experiment with these ideas.

Objectives

To understand the qualitative relationships between magnetic flux (field lines through an area), changing magnetic flux, and current induced in a conducting loop.

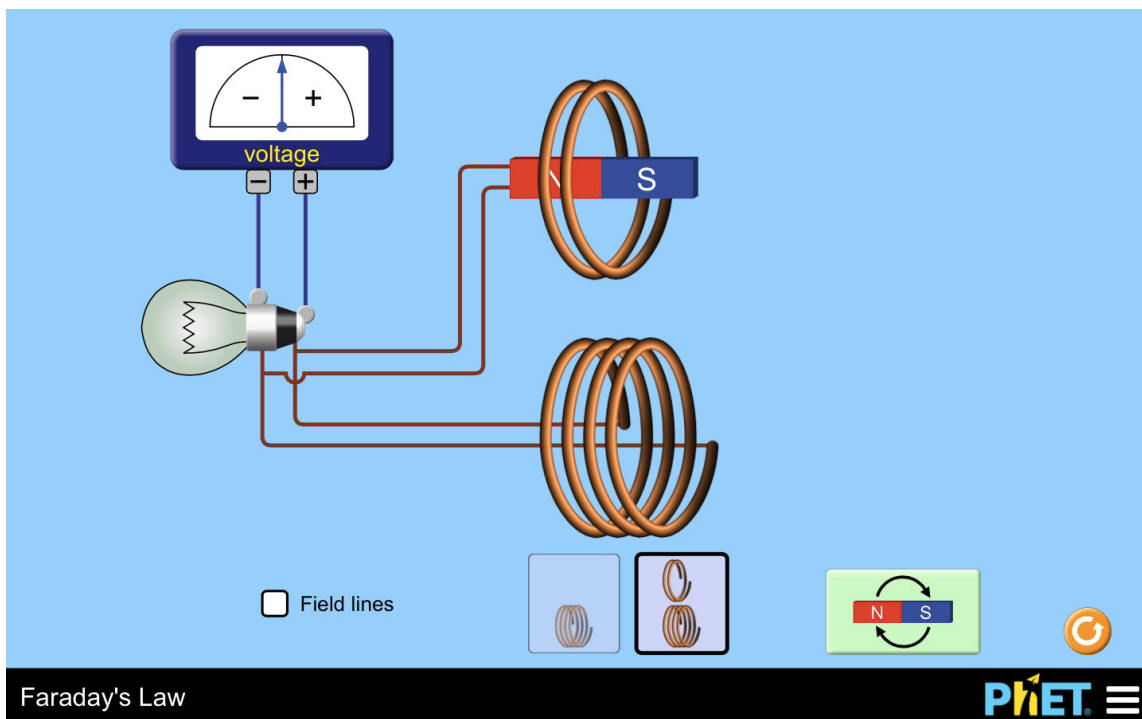
Procedure

- Go to the PhET page at https://phet.colorado.edu/sims/html/faradays-law/latest/faradays-law_en.html or go to the PhET page at <https://phet.colorado.edu> and navigate to the HTML5 version of the Faraday's Law simulation.



- Magnetic fields
 - When the simulation first launches, a red-blue bar magnet is shown (see above). Based on what you already know about the magnetic fields of magnets, visualize what the magnetic field of this bar magnet looks like, including what general shape the field lines have, and which direction the magnetic field is oriented in the area around the magnet.
 - Now, click the “Field lines” checkbox. Were your predictions confirmed? Draw the magnetic field lines for the magnet in the diagram above.

3. Magnetic flux
 - a. The coil of wire in the center of the screen encompasses an area through which magnetic field lines pass, so there is a *magnetic flux* through those coils. With the magnet stationary, is this magnetic flux producing any flow of current or potential difference? _____
 - b. Click on the magnet to move it around on the screen some. What effect does the moving magnet have on the amount of *magnetic flux* in the coils of the circuit?
 - c. What corresponding effect does this have on the flow of current, or potential difference?
 - d. Move the magnet around in a variety of ways. Identify as many ways as you can find of *increasing* the potential created, and list them here. Consider using other buttons in the simulation in your investigation.



- e. If you haven't already, click on the icon that produces two loops of conducting wire as shown here. Which conducting loop more readily allows an electric potential to be produced?

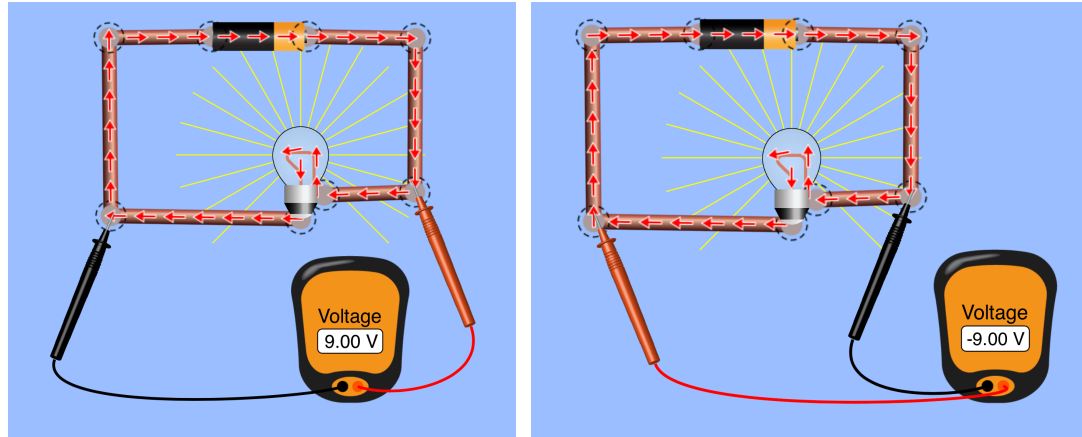
4. Lenz's Law

- a. Reset the simulation so that a single magnet is displayed, with field shown. With that magnet on the right side of the screen and in line with the coil, move it so that it approaches but doesn't enter the area of the coil.
 - i. Which direction is the magnetic field pointing as the magnet approaches the coil?
 - ii. Is the flux through the area of the coil *increasing* or *decreasing* as the magnet approaches?

Lab: Faraday's Law

AP Physics

- iii. NOTE: Conventional currents run from high potential to low potential. Voltmeters indicate *positive* potential difference when the red (+) end of the voltmeter is connected to the high potential side of something like a battery, resistor, or capacitor (see diagram). If the black (–) end of the voltmeter is connected to the high potential, the voltmeter will display a potential difference that is *negative*.



- iv. As the magnet approaches the coil, which direction is the current induced in the coil flowing (according to the voltmeter): up in front and down in back, or up in back and down in front?
- b. Now, place the magnet so that it is inside the coil, then move it to the left so that the magnet is leaving the area of the coil.
- Which direction is the magnet's field pointing as the magnet leaves the coil?
 - Is the flux *increasing* or *decreasing* as the magnet leaves the coil?
 - As the magnet leaves the coil, which direction is the current induced in the coil flowing (according to the voltmeter): up in front and down in back, or up in back and down in front?
- c. Look up **Lenz's Law** in your textbook, on Wikipedia, etc., and write the definition you find here.
- d. Is the behavior of the circuit in the PhET simulation consistent with the description of Lenz's Law you found?