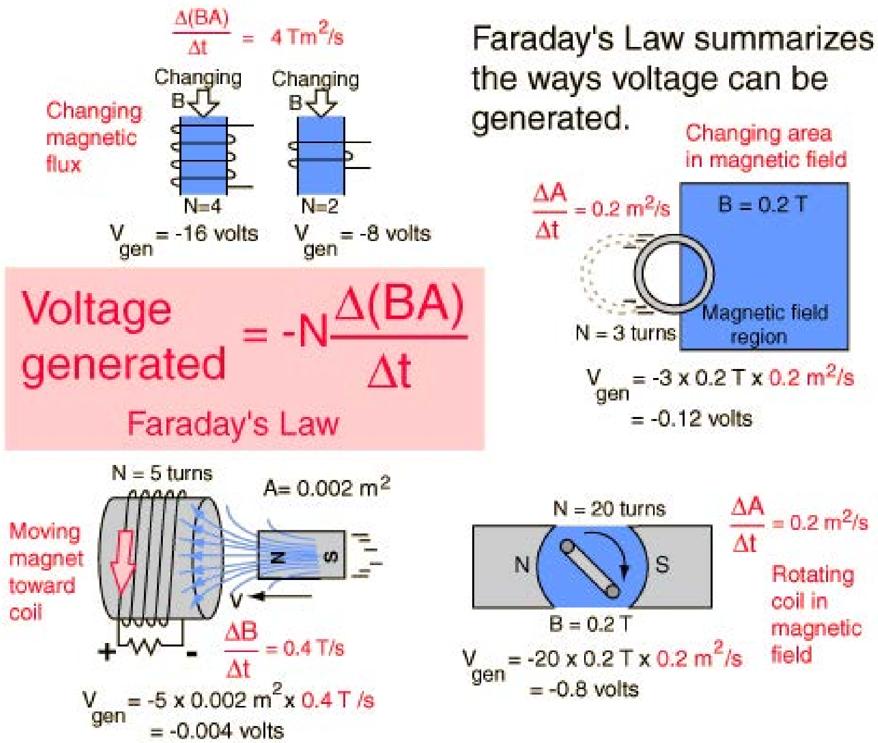
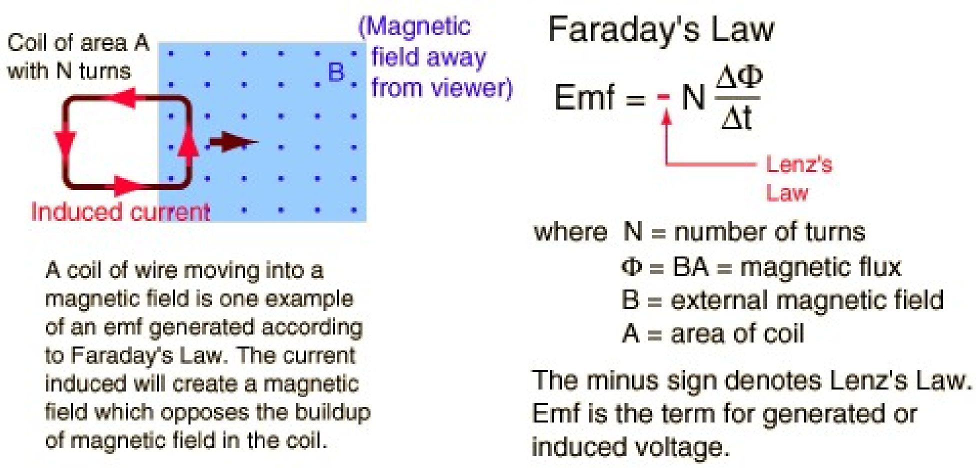
Faraday's Law

(Georgia State University)

Any change in the magnetic environment of a coil of wire will cause a voltage (emf) to be "induced" in the coil. No matter how the change is produced, the voltage will be generated. The change could be produced by changing the magnetic field strength, moving a magnet toward or away from the coil, moving the coil into or out of the magnetic field, rotating the coil relative to the magnet, etc.

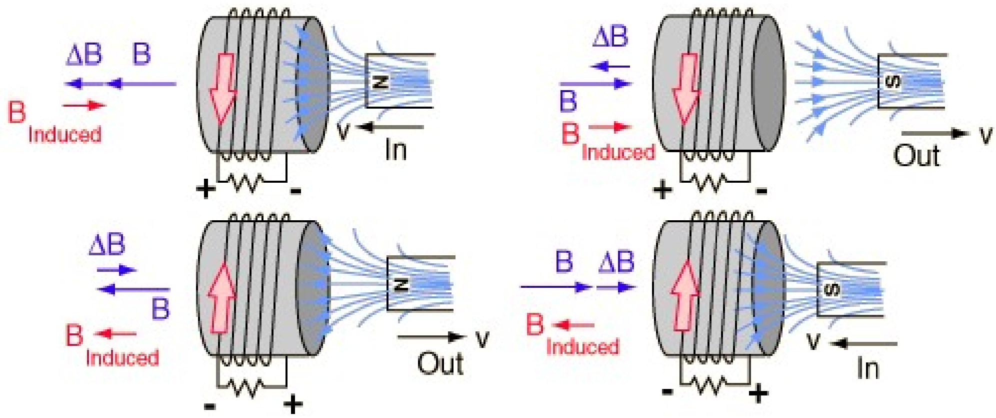


Faraday's law is a fundamental relationship which comes from Maxwell's equations. It serves as a succinct summary of the ways a voltage (or emf) may be generated by a changing magnetic environment. The induced emf in a coil is equal to the negative of the rate of change of magnetic flux times the number of turns in the coil. It involves the interaction of charge with magnetic field.



Lenz's Law

When an emf is generated by a change in magnetic flux according to Faraday's Law, the polarity of the induced emf is such that it produces a current whose magnetic field opposes the change which produces it. The induced magnetic field inside any loop of wire always acts to keep the magnetic flux in the loop constant. In the examples below, if the B field is increasing, the induced field acts in opposition to it. If it is decreasing, the induced field acts in the direction of the applied field to try to keep it constant.



Magnet and Coil

When a magnet is moved into a coil of wire, changing the magnetic field and magnetic flux through the coil, a voltage will be generated in the coil according to Faraday's Law. In the example shown below, when the magnet is moved into the coil the galvanometer deflects to the left in response to the increasing field. When the magnet is pulled back out, the galvanometer deflects to the right in response to the decreasing field. The polarity of the induced emf is such that it produces a current whose magnetic field opposes the change that produces it. The induced magnetic field inside any loop of wire always acts to keep the magnetic flux in the loop constant. This inherent behavior of generated magnetic fields is summarized in Lenz's Law.