



James Clerk Maxwell



Michael Faraday

Electromagnetism

Electromagnetic Induction

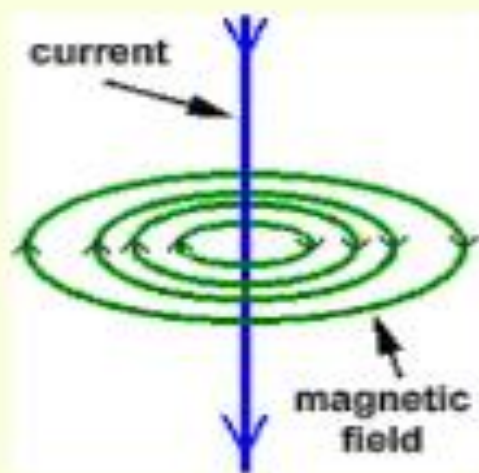
Electromagnetic Waves

Electromagnetism

- Electricity and magnetism are different facets of *electromagnetism*
 - a moving electric charge produces magnetic fields
 - changing magnetic fields move electric charges
- This connection first elucidated by Faraday, Maxwell
- Einstein saw electricity and magnetism as frame-dependent facets of *unified* **electromagnetic** force

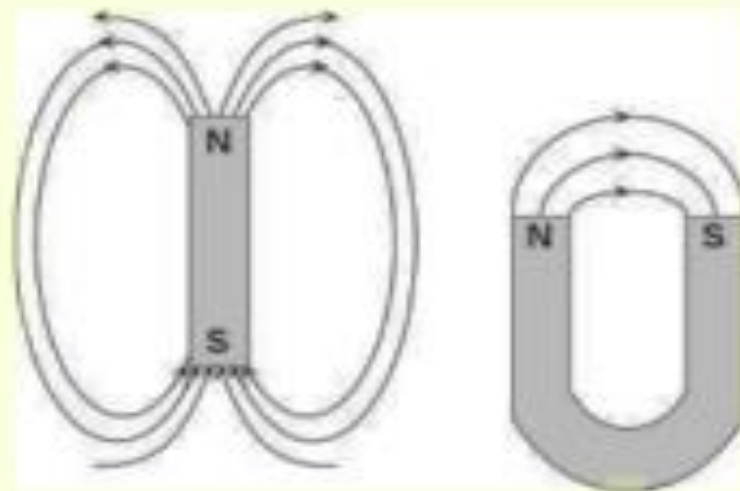
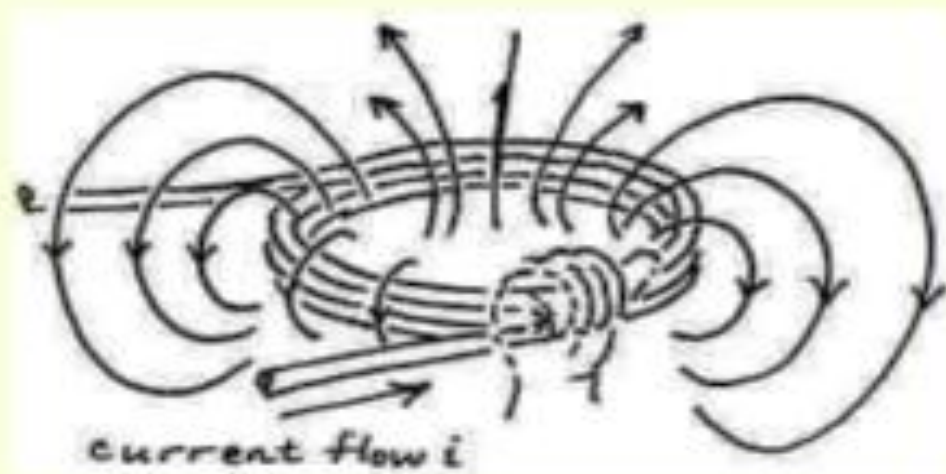
Magnetic fields from electricity

- A static distribution of charges produces an electric field
- Charges in *motion* (an electrical current) produce a magnetic field
 - electric current is an example of charges (electrons) in motion



Electromagnets

- Arranging wire in a coil and running a current through produces a magnetic field that looks a lot like a bar magnet
 - called an electromagnet
 - putting a real magnet inside, can shove the magnet back and forth depending on current direction: called a solenoid



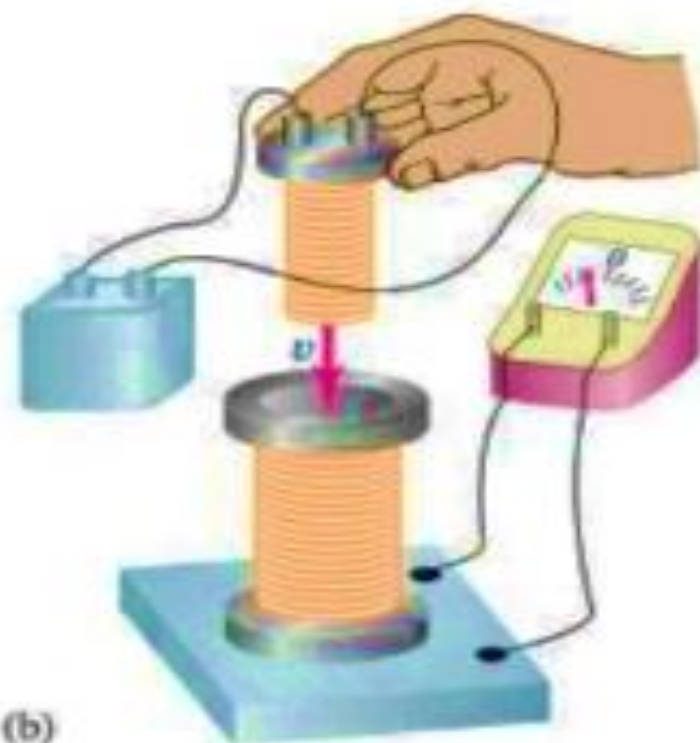
Induced Current

- The next part of the story is that a *changing magnetic field* produces an electric current in a loop surrounding the field
 - called electromagnetic induction, or Faraday's Law



(a)

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(b)



(c)

The Electromagnetic Connection

- *A changing magnetic field produces an electric field, and a changing electric field produces a magnetic field.*
- Electric and Magnetic fields can produce forces on charges
- *An accelerating charge produces electromagnetic waves (radiation)*
- Both electric and magnetic fields can transport energy
 - Electric field energy used in electrical circuits, e.g., released in lightning
 - Magnetic field carries energy through transformer, for example