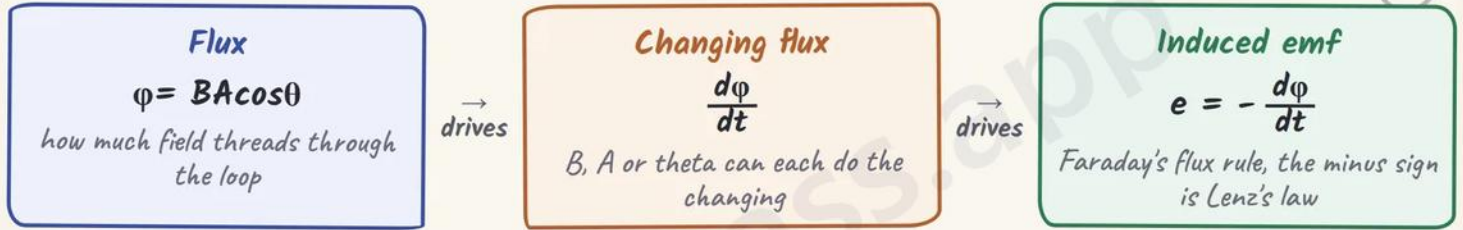


a changing flux drives an emf, rotating rods, self and mutual inductance, and the transformer

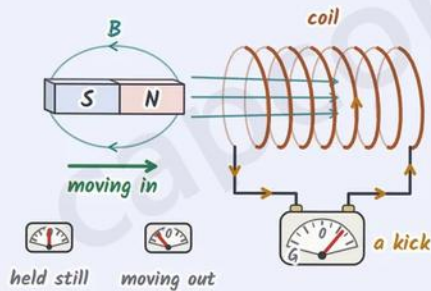


Faraday's experiments: a magnet or a coil moved near a closed coil, or a neighbouring current switched on or off, all induce a current

Faraday's laws of electromagnetic induction

*

- **first law**: a changing flux through a closed circuit induces an emf
- a conductor cutting field lines has an emf between its ends
- **second law**: the emf is proportional to the rate of change of flux
- N turns in series: $e = -N d\phi'/dt$, ϕ' the flux per turn
- with Lenz's law, the **flux rule**: $e = -d\phi/dt$, volts and webers



N end pushed in: a kick; held still: none; pulled out: the other way

is the flux through the loop increasing or decreasing?

increasing

decreasing

induced current opposes the increase

sets up its own field opposite to the original flux

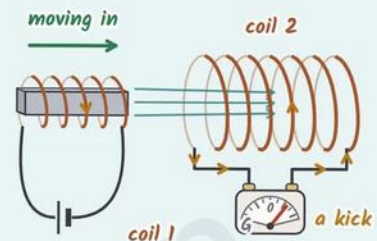
induced current opposes the decrease

sets up its own field reinforcing the original flux

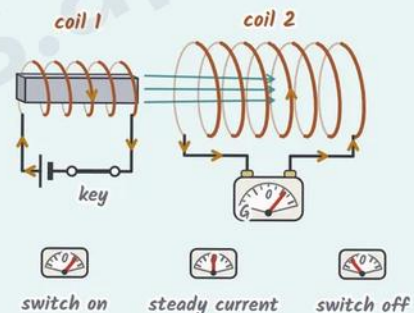
Lenz's law: the induced current opposes the **CHANGE** producing it, never the flux itself; energy conservation demands it

Two coils: the same kick

- a current-carrying coil carried in acts like the magnet
- coils still: a kick only at switch on and off



coil 1 and its cell carried in



kicks at on and off, none while steady