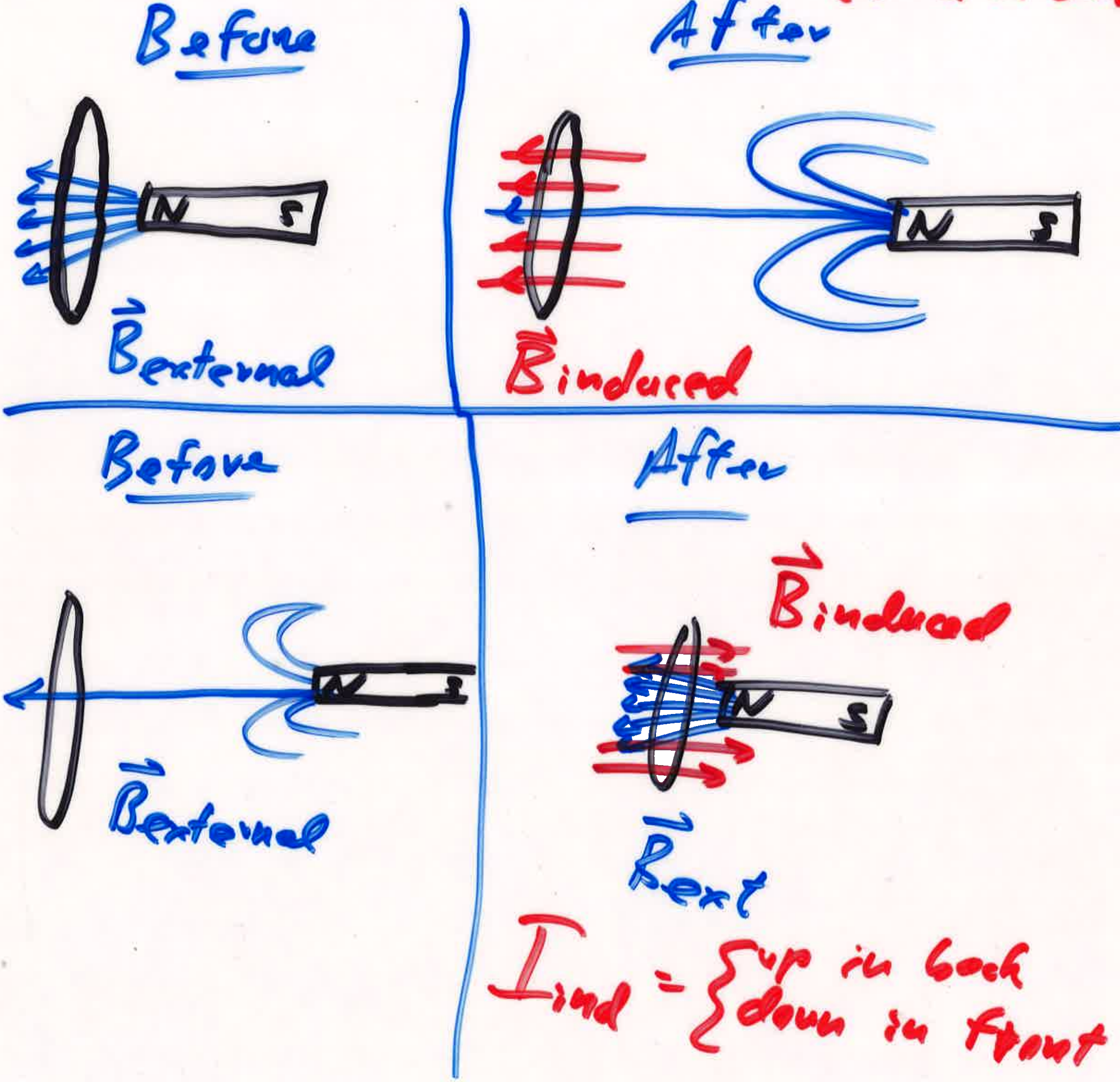
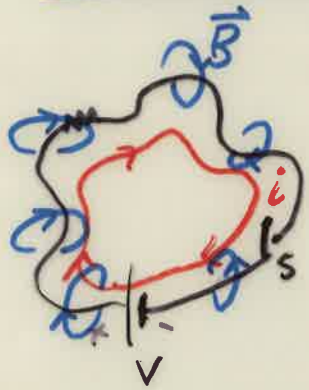
Lenz's Law

"Lenz's law tries to maintain the status quo."

$I_{ind} = \begin{cases} \text{up in front} \\ \text{down in back} \end{cases}$



Self Inductouse (L)



Suppose that you want to start current flowing in a circuit.

when you close the switch, the external voltage V will begin to push charges around the loop, a current i, time dependent.

But this current will produce a magnetic field, $\vec{B}$. Some of the $\vec{B}$ lines will penetrate the loop giving a magnetic flux Φ_B. Because the current changes in time, so does the flux.

The changing magnetic flux gives rise to a back e.m.f. $\mathcal{E}'$ by Faraday's Law-

$$\mathcal{E}' = -\frac{d\Phi_B}{dt} = -\frac{d}{dt}\iint_{\text{Area of loop}} \vec{B}\cdot d\vec{A}$$

This is a little push against the battery voltage.

Since $\Phi_B \propto B$ and $B \propto i$

we have

$$\mathcal{E}' = -\frac{d\Phi_B}{dt} \propto \frac{di}{dt}$$

The constant of proportionality is called the (self) inductance

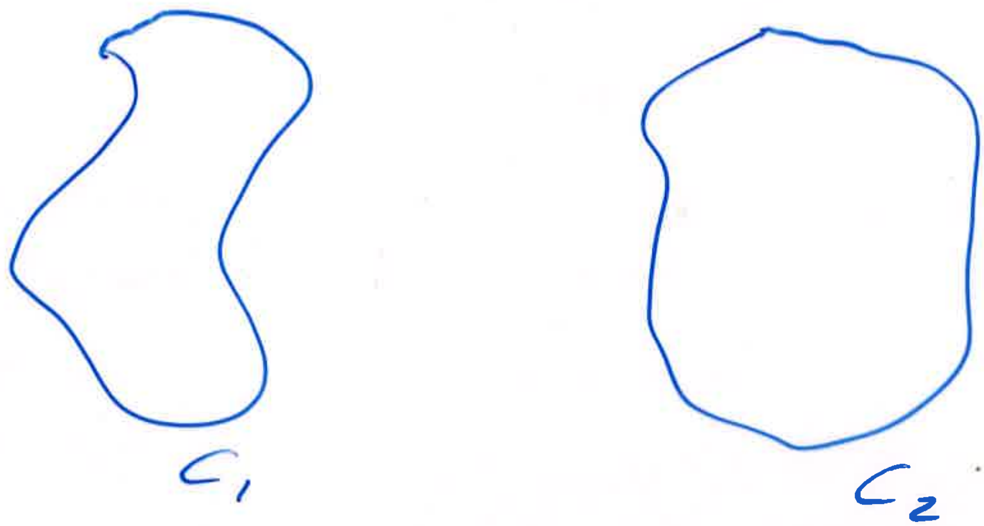
$$\mathcal{E}' = -L\frac{di}{dt}$$

$Q = CV$

The MKS unit of inductance is the henry (H).

$$H = \frac{V \cdot s}{A}$$

Mutual Inductance (M)



changing the current in loop 1 induces an e.m.f. in loop 2

$$\mathcal{E}_2 = -M \frac{di_1}{dt}$$

changing the current in loop 2 induces an e.m.f. in loop 1

$$\mathcal{E}_1 = -M \frac{di_2}{dt}$$