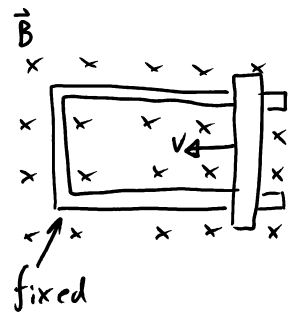
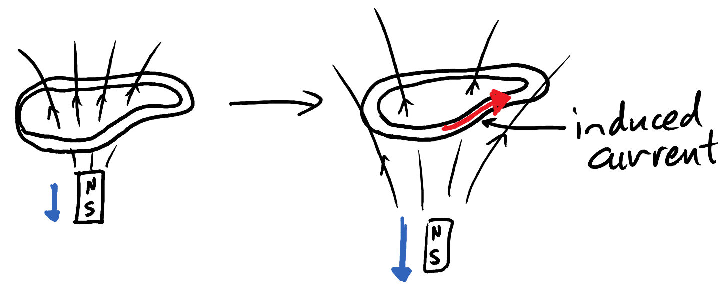
LAST TIME: INDUCTION

Changing magnetic flux through loop $\xRightarrow{\text{induces}}$ current in loop such that $\vec{B}$ from current opposes change in flux.





CASE 1: LOOP CHANGING

↓

conductor moving through field

↓

magnetic forces on charges

↓

induced current

CASE 2: MAGNETIC FIELD CHANGING

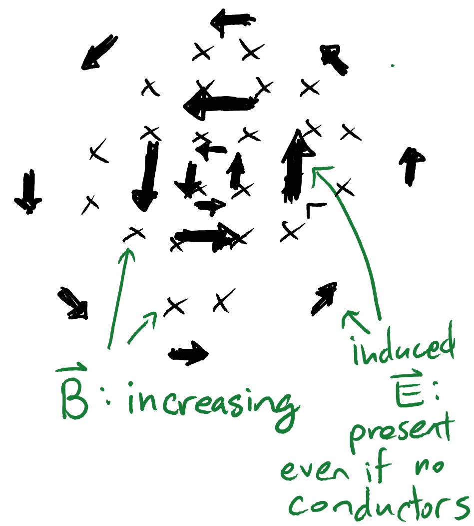
CAUSES ELECTRIC FIELD

↓

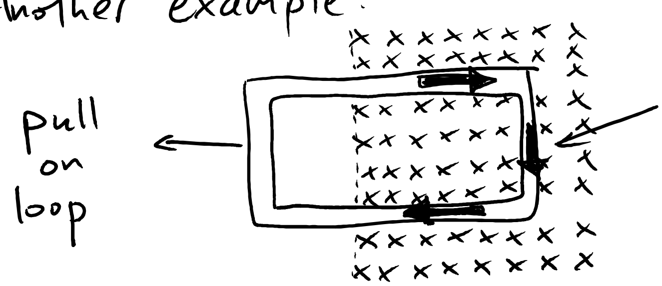
electric forces on charges

↓

induced current



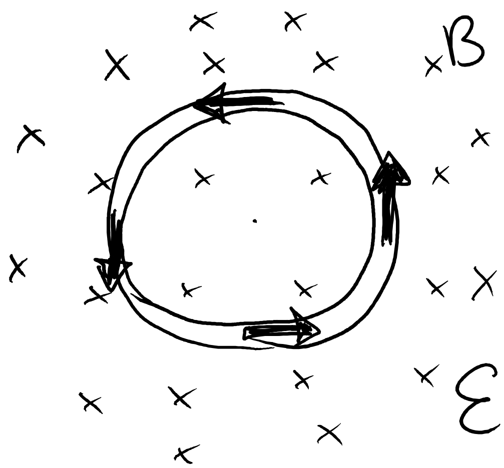
Another example:



induced current: results in magnetic force on wire that resists pulling

Need to do work on circuit to extract it — this is the energy that gets dissipated by I induced flowing (i.e. I^2R power)

FARADAY'S LAW gives magnitude of $\mathcal{E}$ = EMF



B increasing

previously assumed this was zero!

$\mathcal{E}$ = net "voltage drop" around loop

KIRCHOFF'S LOOP LAW MODIFIED IF CHANGING FLUX THROUGH LOOP!

$\mathcal{E} \cdot q$ = work done moving charge around complete loop

For resistance R will have $I = \dfrac{\mathcal{E}}{R}$.

Faraday's Law says

$$|\mathcal{E}| = \left|\frac{d\Phi_M}{dt}\right|$$

fancy formula:

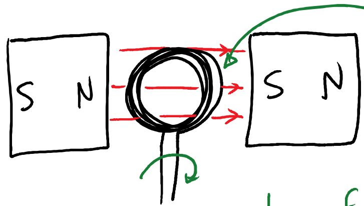
$$\mathcal{E} = \int_{\substack{\text{around}\\\text{loop}}} \vec{E} \cdot d\vec{\ell}$$

only nonzero if Φ is CHANGING

larger $\mathcal{E}$ if Φ changes faster.

NOTE: Previously we always had the net work moving a charge around a circuit = 0 (Kirchoff's loop law). With a changing magnetic flux through the loop, this result is modified!

MAJOR APPLICATION: electric generators:



N turns $\Rightarrow$ flux is $B_\perp \cdot \text{Area} \cdot N$

spin around $\Rightarrow$ flux through coil oscillates

$\Rightarrow$ oscillating current induced

EXTRA:

Fact that work done around a loop is not zero means that the force is NONCONSERVATIVE.

recall: for $\vec{E}$ from charges, work done was independent of the path.

Equivalently $\vec{E}$ was the derivative of a POTENTIAL V, and the work done bringing a charge from one place to another was $\Delta V \cdot q$.

★ For $\vec{E}$ from changing $\vec{B}$, we can't write $\vec{E}$ as the derivative of a potential ★