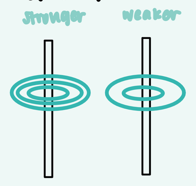
Electromagnetism

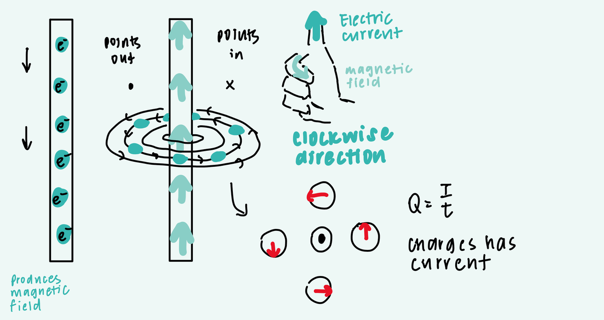
spacing indicates strength



Electromagnetism

- current ⚡ ⇒ magnetic field

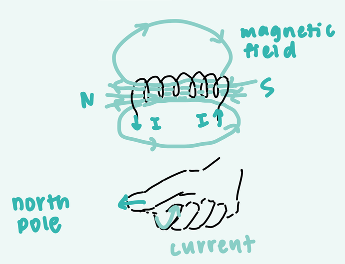
Straight wire



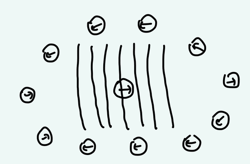
$Q = \frac{I}{t}$

charges has current

Coil

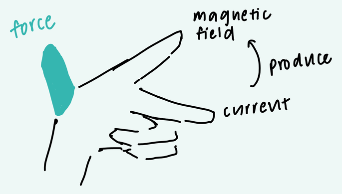


- current of solenoid
- # of turns
- presence of soft iron core inside solenoid / unit length



1) concentric circles
2) spacing should increase in → out

Flemming's left hand rule



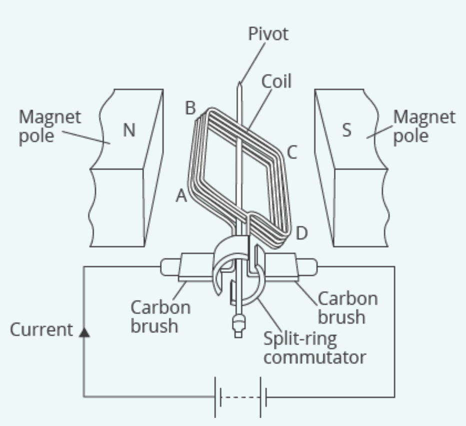
Introduce a permanent magnet in a current - carrying wire

↳ Both magnetic fields interact to produce a resultant magnetic field where a force is induced

Application: DC motor

magnetism + current → force

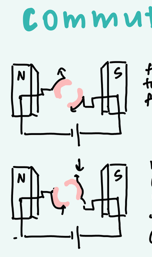
- to create continuos rotation, current is reversed (LHR) every half a turn



split ring

↳ device that reverses current every half a turn

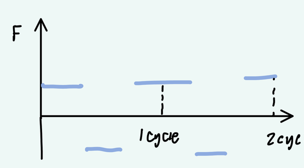
commutator



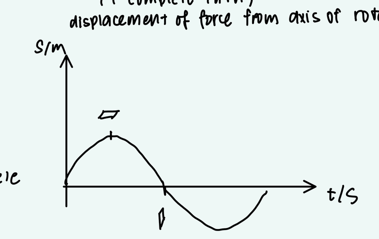
forces can't turn it much further

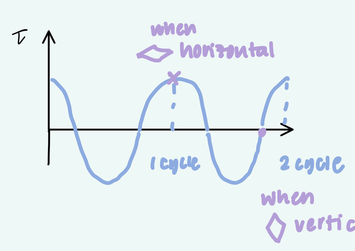
when coil overshook commutator changes current direction so forces a turn (when vertical)

graphs of coil



(1 complete turn) displacement of force from axis of rotation



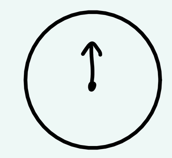


Electromagnetic Induction

magnetic field ⇒ current ⚡

- when a wire ⊥ magnetic field, emf is induced
  increases by
  1) moving the wire faster
  2) using a stronger magnet
  3) increasing wire length

galvameter



points in current direction

↳ need change else no EMF

Faraday's Law

Magnitude of induced EMF ($\mathcal{E}$) in a conductor is directly proportional to the rate of change of magnetic flux-linkage or to the rate of cutting magnetic flux

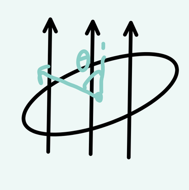
$$\mathcal{E} = \frac{d\Phi}{dt}$$

- EMF always induced
- current only induced wh circuit is closed

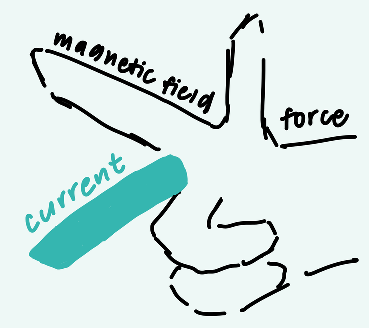
$$\Phi = BA\cos\theta$$

← Area perpendicular to magnetic field

↗ magnetic field



Flemming's right hand rule



only 1 from each row or no $\mathcal{E}$ induced

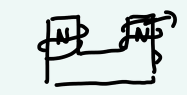
Lenz's Law

→ determines the polarity of a coil

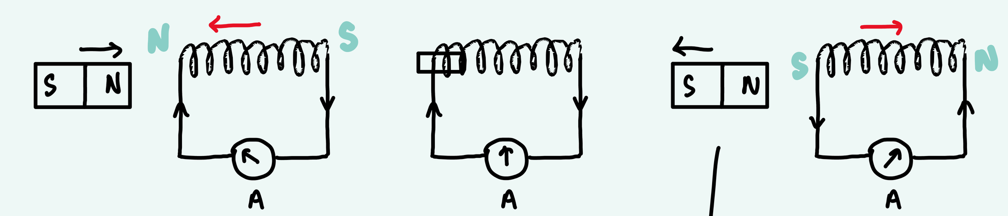
- direction of induced current is such that it produces a magnetic field that opposes the change in magnetic flux that causes it

$$\boxed{\mathcal{E} = -\frac{d\Phi}{dt}}$$

if no continuos change, deflection will stabilize as $\frac{d\Phi}{dt} = 0$

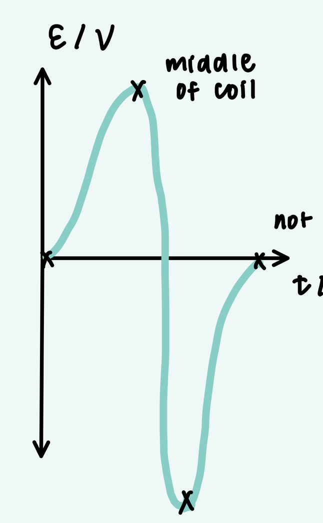


will be induced due to Lenz law (repulsion)

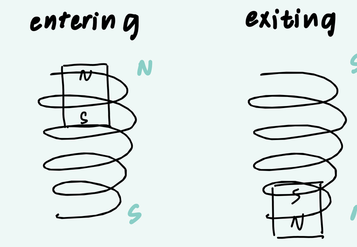


if both magnet and coil don't move

equivalent to closing & opening switch of electromgnet



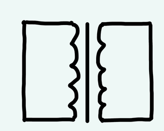
longer as falling faster (a>0)



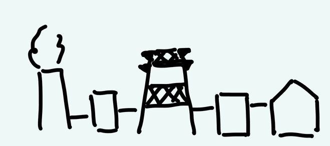
Application: AC generator

alternating current

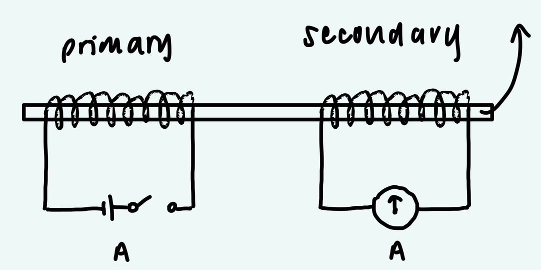
1) Transformer



power distribution



increases / decreases voltages



using a non-magnetic material causes a smaller deflection

changing magnetic flux

total magnetic field lines passing through a single surface

changing magnetic flux linkage

magnetic flux x # of turns in coil

2) AC generator

When an alternating current flows in the primary, an induced magnetic field is produced in the soft magnetic core. This constantly changes the magnetic flux linkage in the secondary coil inducing an alternating $\mathcal{E}$.

turns ratio (not reciprocal)

$$\boxed{\frac{V_s}{V_p} = \frac{N_s}{N_p}} = \frac{I_s}{I_p}$$ } for ideal transformers

$V_p\uparrow$ $V_s\downarrow$ step up transformer

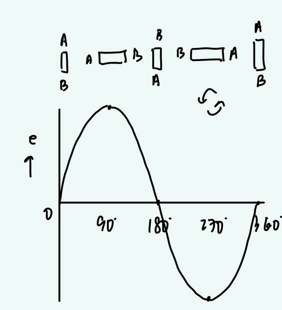
$V_p\uparrow$ $V_s\downarrow$ step down transformer

force + magnetism → current

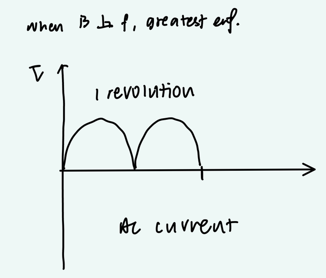
(if you don't change poles → no split ring)

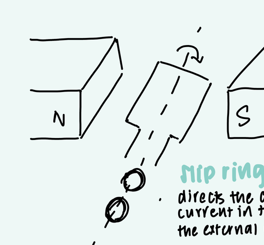
- current alternates every half a revolution

slip ring



when B ⊥ f, greatest emf.





slip ring

- directs the alternating current in the coil to the external circuit

Joules heating law

$$P_{loss} = I^2R$$

$P_{initial} = P_{final} + P_{loss}$

transmission cable

low current → low voltage

→ less power loss.