Diode Rectification (AC → DC)

Diodes used in rectifiers ↗

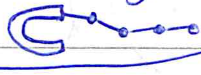
also in light detector circuits (LDR) — R increases as it gets dark
R decreases as it gets bright

also L.E.Ds to emit light

* normally get a resistor in series with diode to protect it from current that is too large.

MAGNETISM: lodestone, magnetite is naturally magnetised

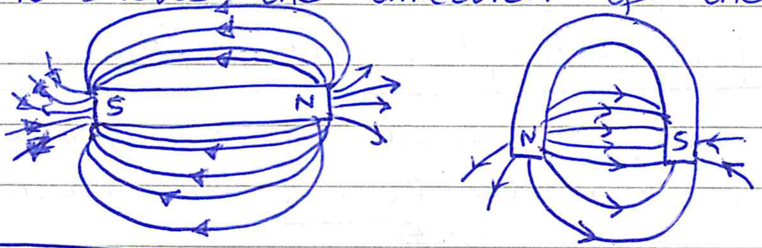
Ferromagnetic materials are attracted to magnets (e.g. iron) (nickel, cobalt).

A magnet magnetises ferromagnetic materials when they are close (eg. Pins 

A magnetic field:
space around a magnet or any region of space where magnetic force can be felt.

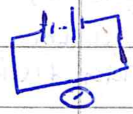
DIRECTION of magnetic field = direction of the force a North pole would experience at that point. ⊘ plotting compass

Magnetic Field Line: Line drawn so that the tangent to it at any point shows the direction of the magnetic field at that point.



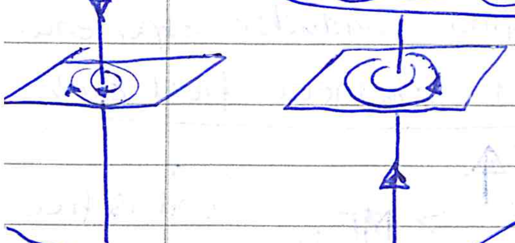
can use iron filings or plotting compasses

In 1819 Hans C. Oersted discovered that a current carrying wire has a magnetic field around it → only when current flows. DEMO!

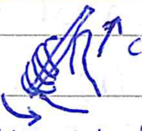


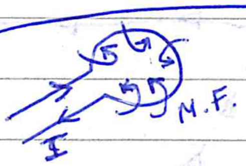
Needle deflects whenever current changes value (or direction)

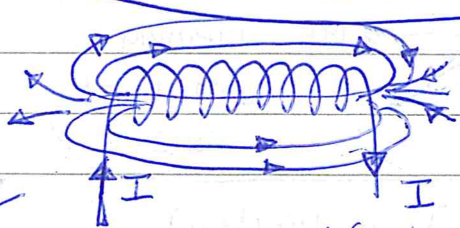
* EVERY current carrying conductor has a magnetic field around it caused by current



Right hand grip rule

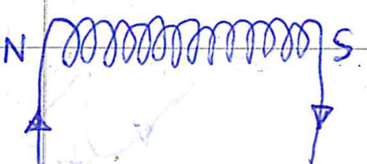




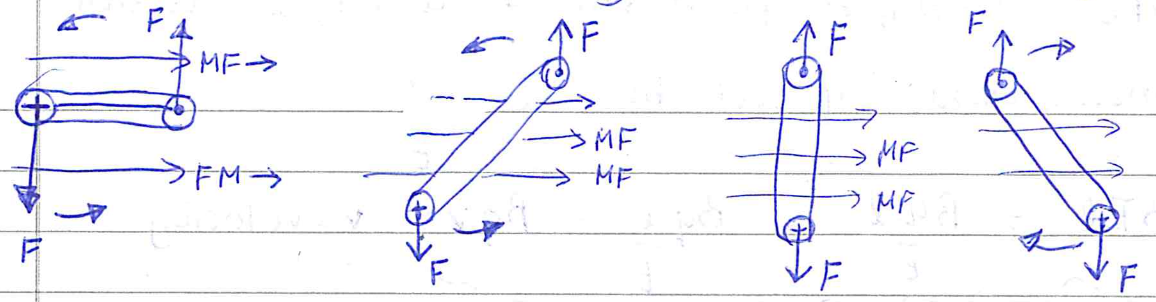


look into loop. If I moves clkwise your end is south

Solenoid (coil whose length is much longer than radius)



As the coil rotates the turning moment on it changes



So the coil would just go anticlkwise to 90° and if it goes beyond the moment of the couple will swing it back so it stays at 90° – UNLESS we reverse the current just as it passes 90°. Then it will continue around till it is next vertical – again we would need to reverse the current direction to keep it moving.

This is the principle of the DC motor.

Force on Conductor $F = BIl$ (for I at right angles to M.Field)

$F = B\cos\theta . Il$ or $F = BIl\cos\theta$ (for I at angle of θ° to M.Field) (MF @ angle θ° to I)

B = Magnetic Flux Density (VECTOR)

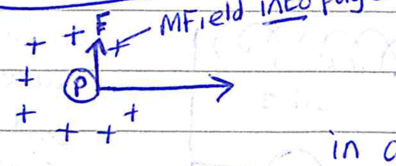
B depends on the strength of magnetic field. B large if Field large.

$B = \frac{F}{Il}$ = vector whose magnitude is = force that would be experienced by a conductor of length 1m carrying a current of 1 Amp at right angles to the M.field at that point. The direction of B = direction of the force on a North Pole at that point. Unit of B = Tesla (T)

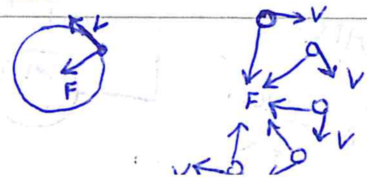
1 Tesla = magnetic flux density at a point if a conductor of length 1m carrying a current of 1 Amp experiences a force of 1N when placed ⊥ to the magnetic field

* Moving charges cause the magnetic field. So even if there was no conductor but there were moving charges there would still be a force experienced by them in a magnetic force field.

Beam of electrons will experience a force if placed in a magnetic field



Proton has force @ ⊥ to its direction. This changes its direction. This force is always at right angles to its direction ⇒ it is forced round in a circle.



Same applies for electron but opp direction

ELECTROMAGNETIC INDUCTION: A changing M.Field in a coil causes an E.M.F. to be induced in the coil. Only if MField is changing!

B = Magnetic flux density = (measure of strength of MF, measure of no. of field lines per unit area = B)

ϕ = Magnetic Flux

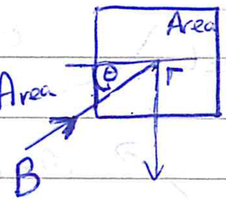
$\frac{\phi}{A} = B$, $\phi = BA$ (= no of flux lines in a given area = ϕ) $\phi_{B \perp A} = BA$

* For $B \perp A$

Units of Flux ϕ = T m^2 = Weber

1 Weber = flux through area of 1m^2 of magnetic flux density 1T

NB: If B is NOT $\perp$ Area then $\phi = BA\sin\theta$ where B is at angle θ to Area



FARADAY's law of EM induction:

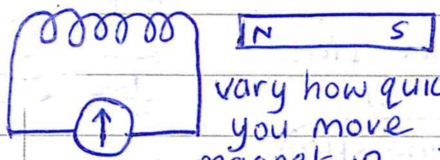
Size of induced EMF $\propto$ rate of change of flux

$E \propto \frac{d\phi}{dt}$; $E = N\frac{d\phi}{dt}$

N = no. of turns on coil

$\frac{d\phi}{dt} = \frac{\text{change in flux}}{\text{time taken}} = \frac{\text{new}\,\phi - \text{old}\,\phi}{\text{time taken}}$

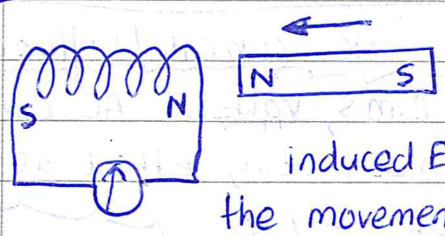
To demonstrate Faraday's law of EM Induction:



vary how quickly you move magnet in and out of coil → Moving magnet quicker makes bigger deflection on galvanometer showing that if the flux changes faster, the current/EMF induced is bigger.

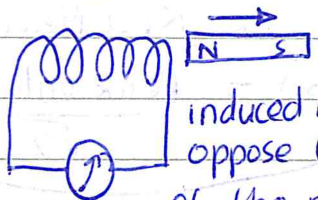
LENZ's law: The direction of the induced EMF/current is ALWAYS such that it opposes the change that caused it.

LENZ's law



induced EMF tries to oppose the movement of the magnet so R.H.S. becomes a N pole to try to repel the magnet

** Could also move coil & keep magnet still **



induced EMF tries to oppose the movement of the magnet so R.H.S. becomes a S pole to try to prevent movement of magnet by attracting it

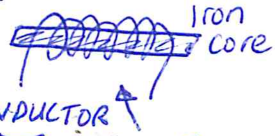
LENZs law follows from the principle of Conservation of Energy

E-Magnetic Induction = principle on which the electric generator is based. Cause a coil to move/rotate in a M Field and a current is induced in it → AC electricity is generated !*!

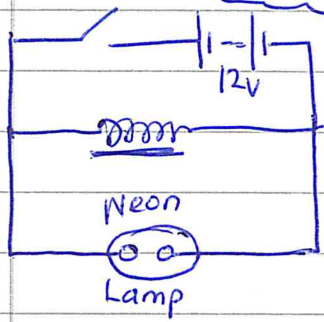
Alternator in a car is turned by the engine and that turns a magnet inside some coils of wire. The changing M Flux causes an EMF/current to be induced in the coil → this is used to provide AC electricity to the electrical system

DYNAMO on bike - wheel turns magnet round coils - induces a current

SELF INDUCTION

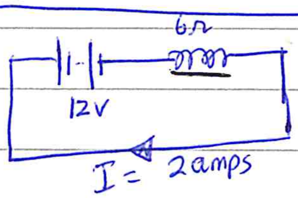


has **more** back EMF than

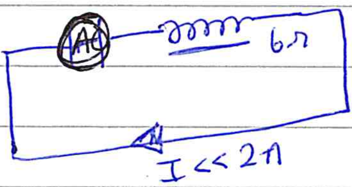


Neon lamp needs 90V to light. Close switch. Neon won't light.
When switch is opened, I in coil suddenly goes to zero. The MF changes (starts to disappear). This causes an EMF to be induced in the coil to oppose the change. The EMF is >90V so neon lamp lights.

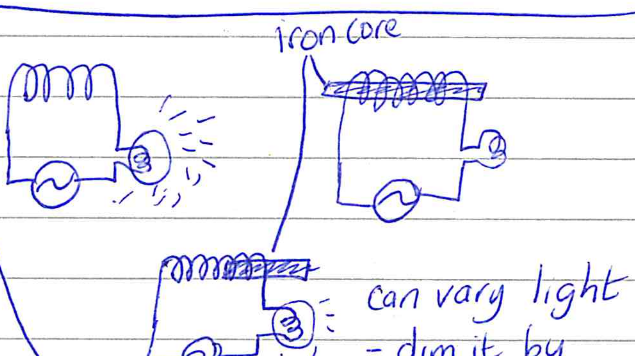
The reason the EMF is so large: (i) Large no of turns on coil (N)
(ii) Coil has soft iron core
(iii) Mag. Field decreases rapidly ($d\phi/dt$)



but



due to back EMF



can vary light - dim it by moving more iron core into coil

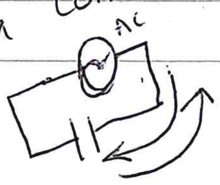
DIMMER SWITCH

Changing frequency of AC means $\frac{d\,flux}{dt}$ $\left(\frac{d\phi}{dt}\right)$ changes. A higher freq means greater rate of change of flux ⇒ greater self induction ⇒ greater 'resistance'

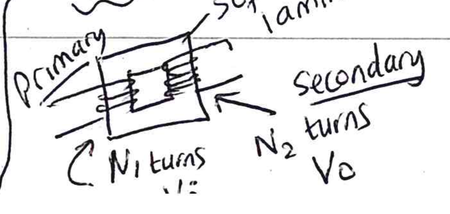
AC and Inductors: Inductor (coil) opposes flow of DC with its ohmic Resistance.
Inductor opposes flow of AC with ohmic Resistance and back EMF due to changing M.Field.
So resistance of inductor is greater when AC source connected.

Inductor → used as Dimmer switch, smooth out DC variations in Power supplies, tuning circuits to tune to different frequencies.

CAPACITORS and AC: A charged capacitor **blocks** DC (current only flows until $V_{capacitor} = V_{power\ supply}$, varies from one direction to the other). Because, in AC, the ... there is a constant flow of current in a circuit with a capacitor



TRANSFORMER:



$$\frac{V_i}{V_o} = \frac{N_p}{N_s}$$

If there are **No** energy losses $V_i I_p = V_o I_s$