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AWESOME PHYSICS

CHAPTER 3

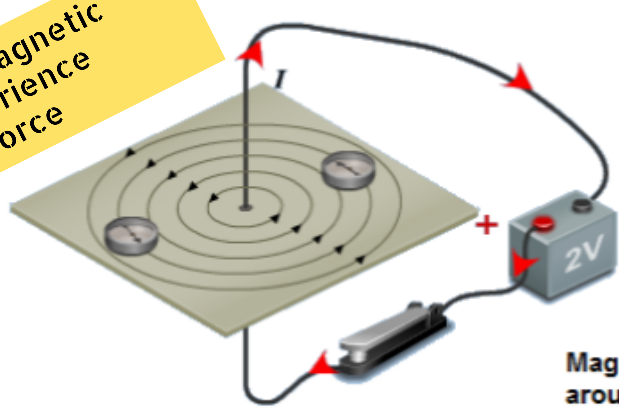
ELECTROMAGNETISME

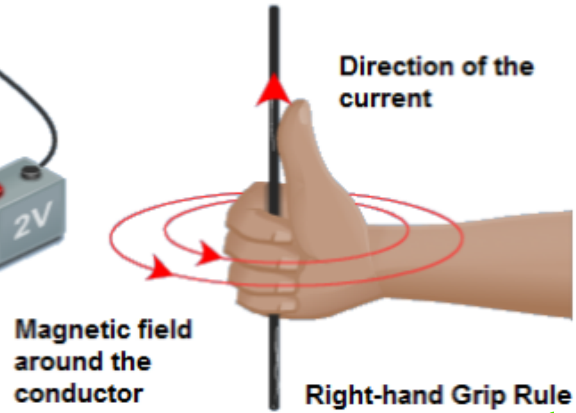
ELECTROMAGNET

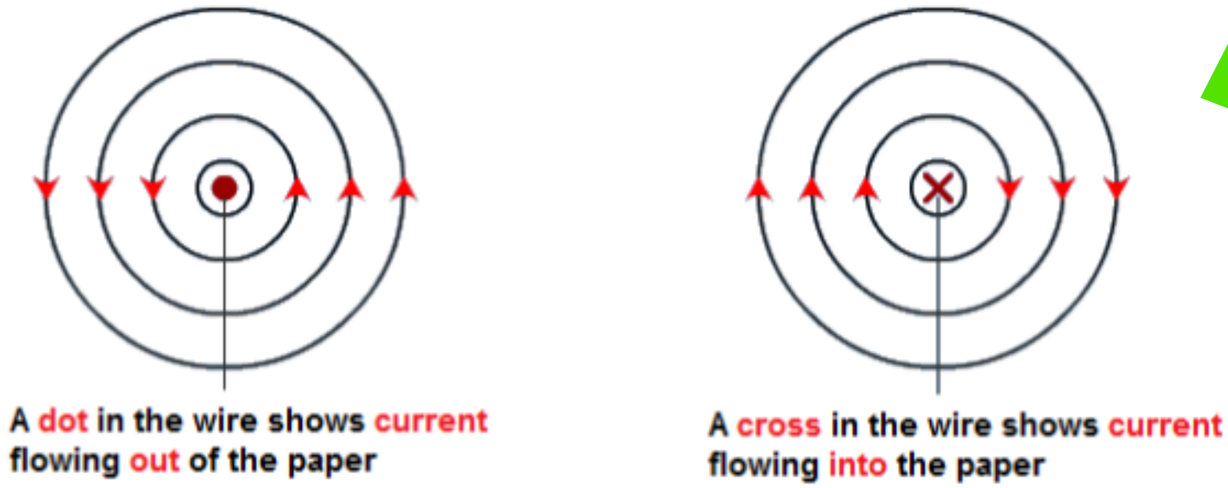
A temporary magnet when current flow through a conductor

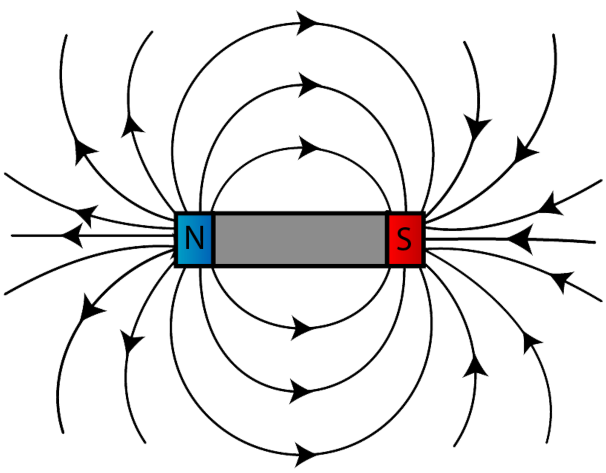
Magnetic field

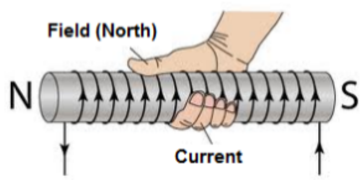
A region where magnetic materials experience magnetic force











combination of coils of wire wounded around on some surface or wounded around an iron core

solenoid

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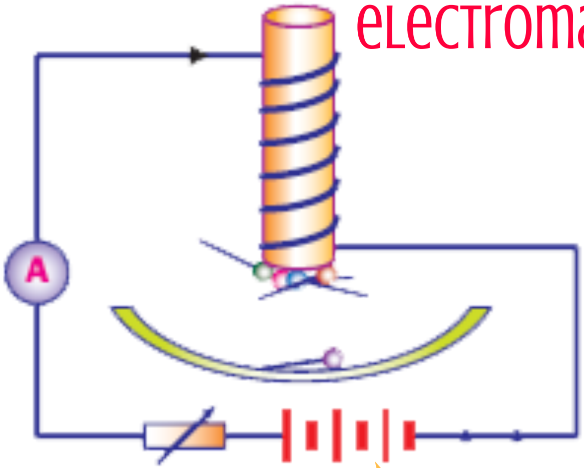
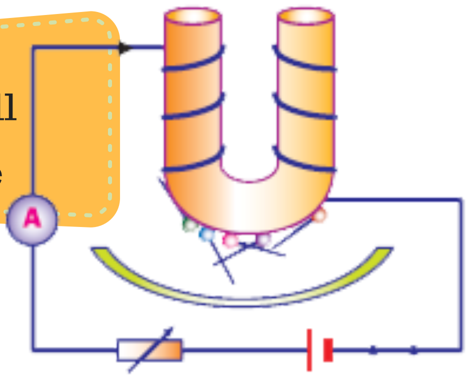
ELECTROMAGNETISME

FACTOR AFFECT THE STRENGTH OF ELECTROMAGNET

CURRENT ↑
NO. OF TURNS ↑
strength of electromagnet ↑



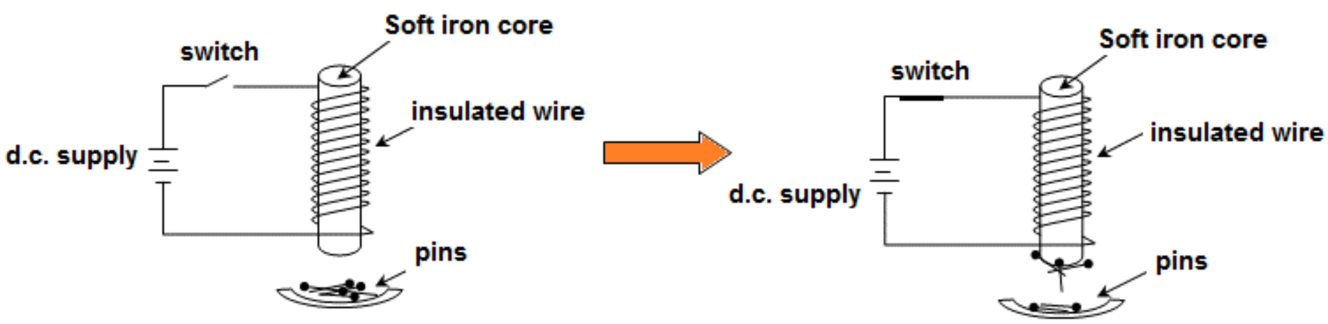
Note:
number of dry cell increase,
current increase



Catch The Cat

CATCH = CURRENT
THE = TURN
CAT = CORE

When there is **no current flows**, soft iron core will **demagnetised**



switch is closed → current flows → magnetic field → soft iron core is magnetised → attracts pins

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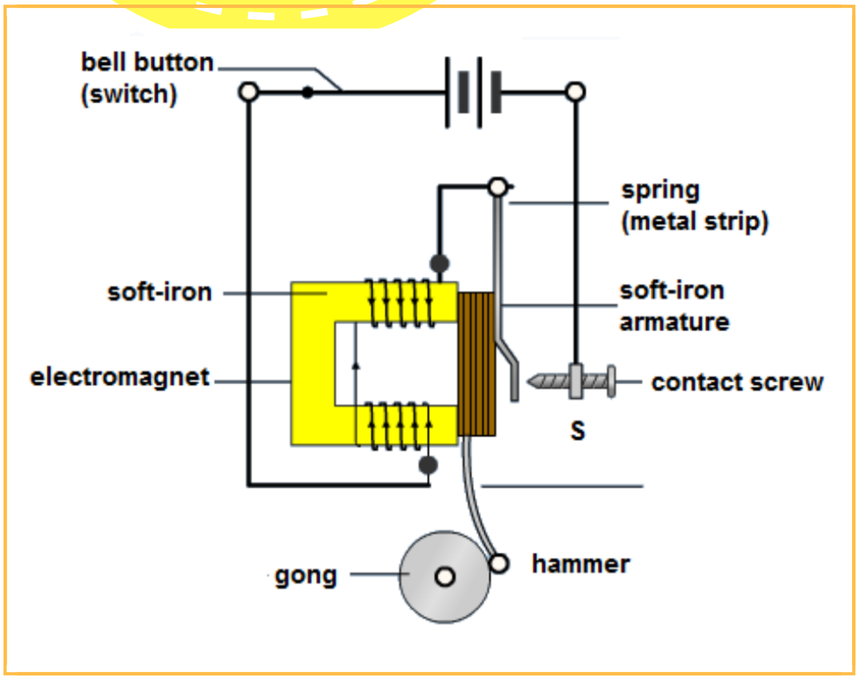
ELECTROMAGNETISME

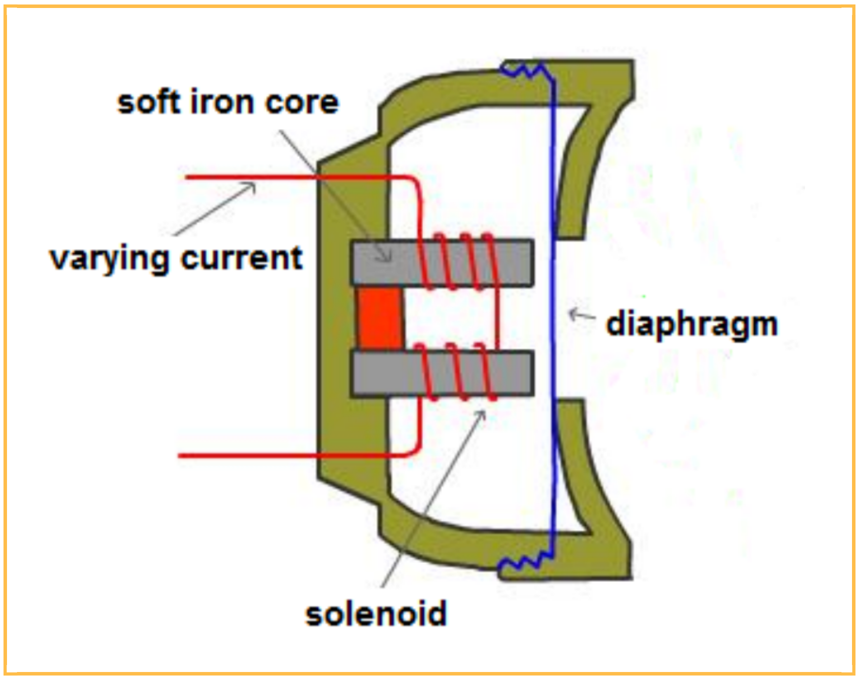
APPLICATIONS OF ELECTROMAGNET

ELECTRIC BELLS



1. When the switch is closed, the current flow will magnetized the soft-iron core.
2. The soft iron armature is pulled toward electromagnet and hit the gong.
3. At the same time, the contact will open and stop the current flows. No electromagnet.
4. The spring mechanism brings the armature back to its original position.
5. The contacts close again and similar process is repeated.

TELEPHONE EARPIECES



1. A varying current received from the caller in telephone line.
2. The varying current passes through solenoid and magnetized the soft-iron core.
3. The electromagnet varies in magnetic strength according to the verifying current.
4. The alloy diaphragm will attract to electromagnet by varying force.
5. Sound produced as compression and rarefaction of air particles

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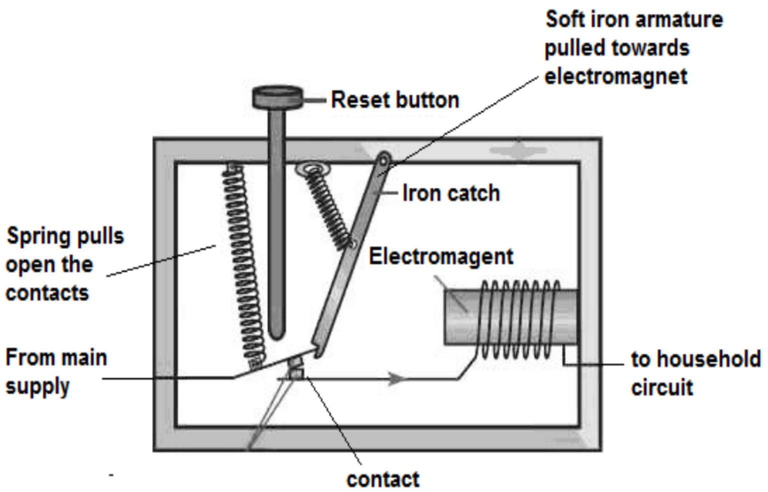
ELECTROMAGNETISME

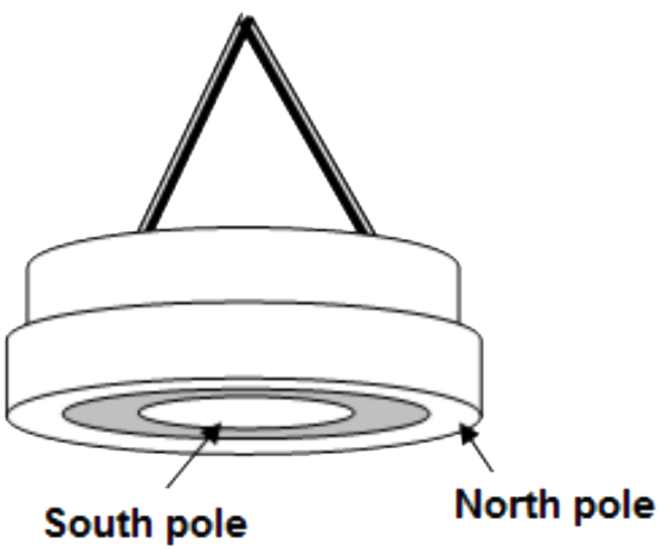
APPLICATIONS OF ELECTROMAGNET



CIRCUIT BREAKERS

Its operate as automatic switch to breaks circuit to open when current becomes too large

1. When the current becomes high (Short circuit) the electromagnet strength increase suddenly.
2. The iron catch is pulled toward electromagnet.
3. The spring pulling apart the contacts
4. The circuit will break and the current flows stop immediately.



LIFTING MAGNET

Its function to move heavy objects or steel from place to place

1. Opposite poles on the surface will produces a stronger magnetic field.
2. When the current is switched on, the soft iron core is magnetized to become a very powerful magnet.
3. Its lifts up iron and steel.
4. When the crane has moved to new location, the current is switched off and the soft-iron core is demagnetized.
5. The objects will fall.

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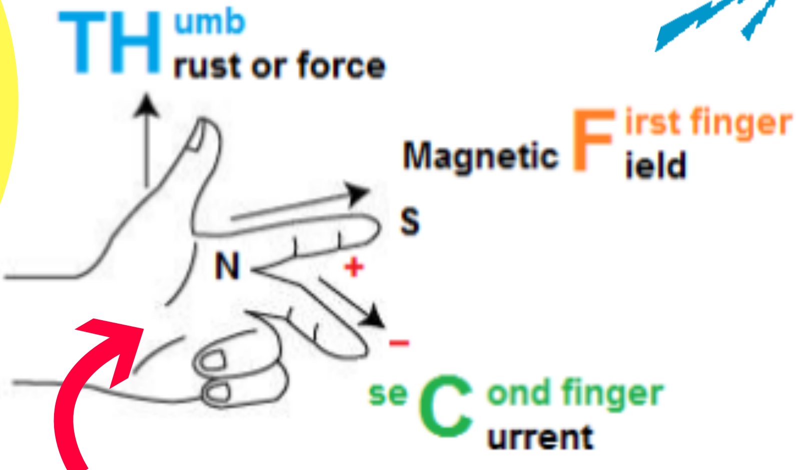
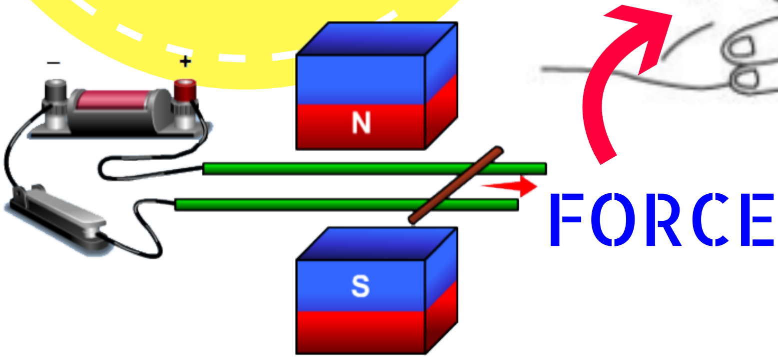
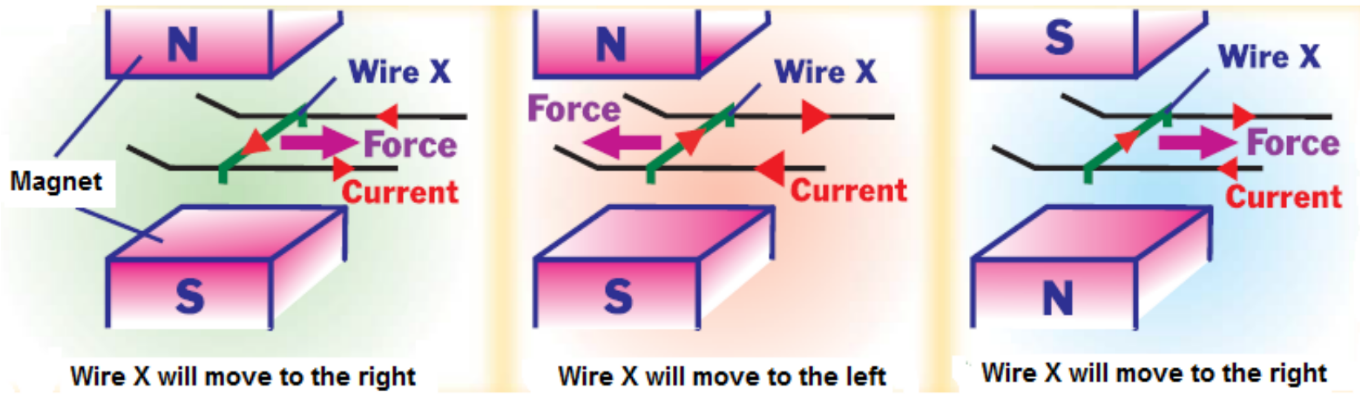
ELECTROMAGNETISME

FORCE ACTING ON A CURRENT-CARRYING CONDUCTOR IN A MAGNETIC FIELDS



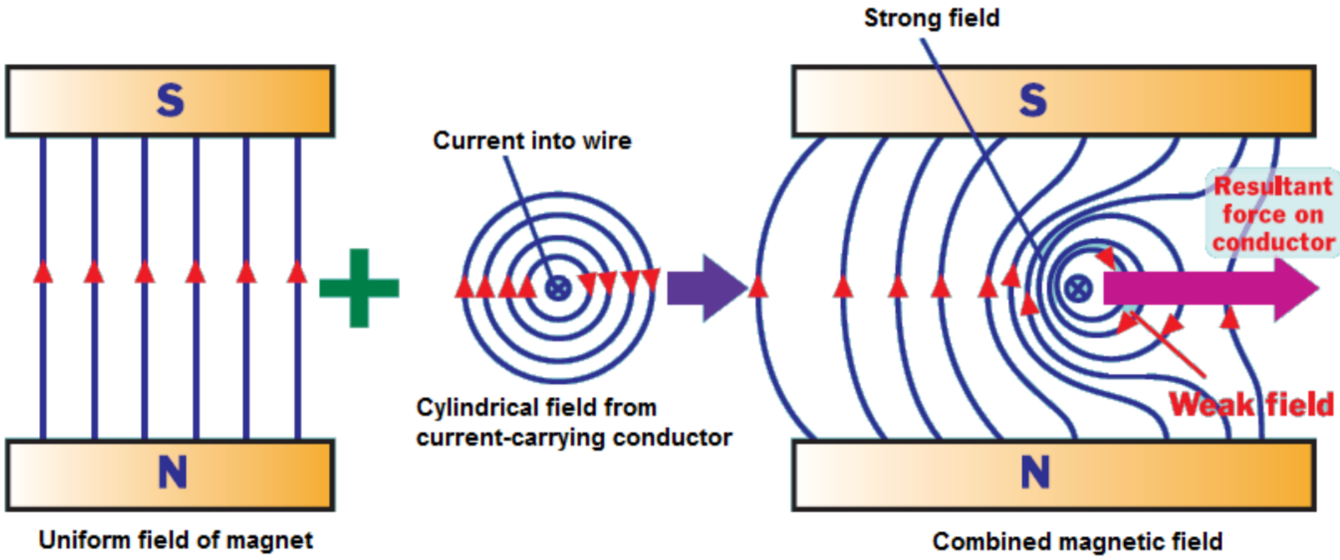


Fleming's Left-Hand Rule



combination of force on current carrying WIRE and magnetic field of permanent magnet

CATAPULT FIELD



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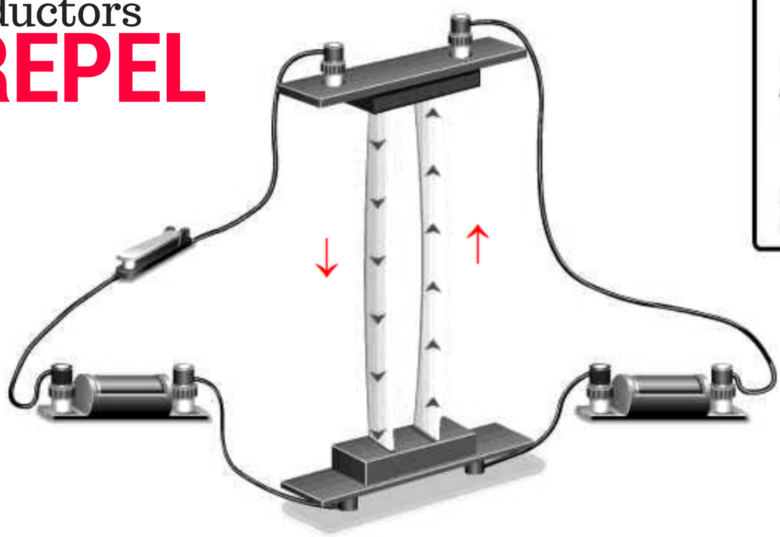
ELECTROMAGNETISME

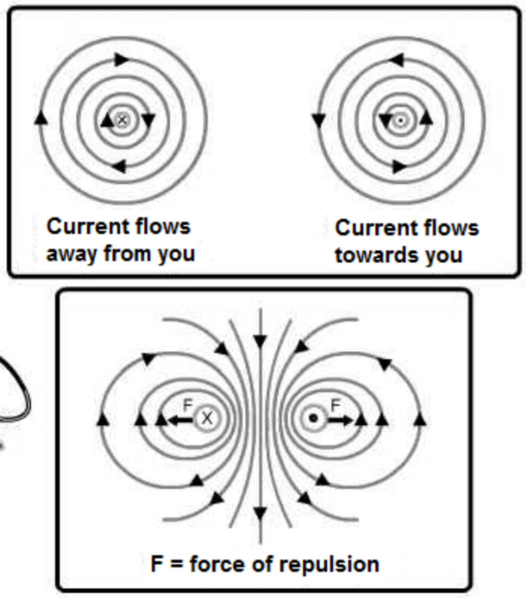
Factors that affect the magnitude of the force on a current-carrying conductor in a magnetic field:

a) Magnitude of current
b) Length of the wire within the magnetic field
c) Strength of magnetic field
d) Angle between current and magnetic field

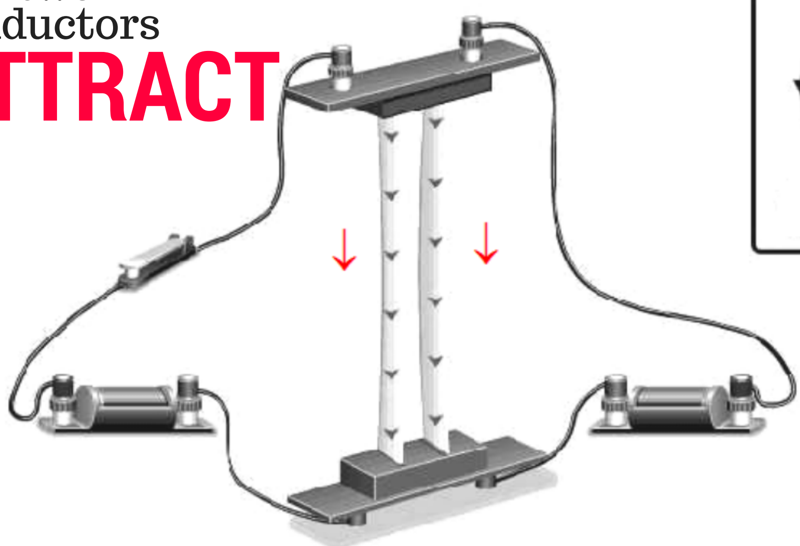
EFFECT OF TWO PARALLEL CURRENT-CARRYING COILS IN A MAGNETIC FIELD

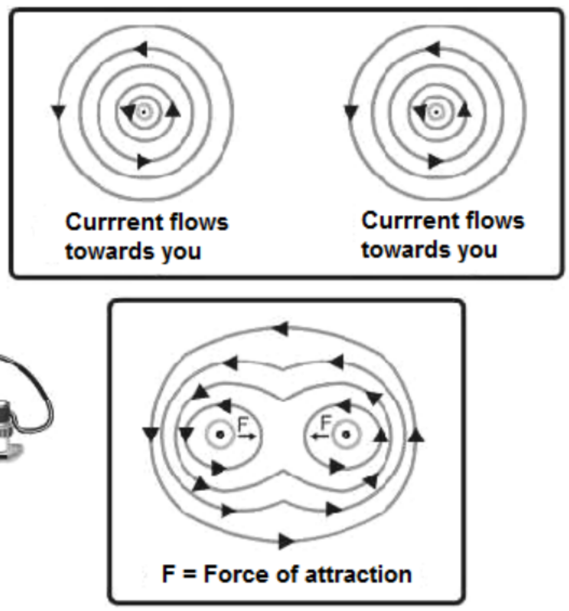
The two conductors **REPEL**





The two conductors **ATTRACT**





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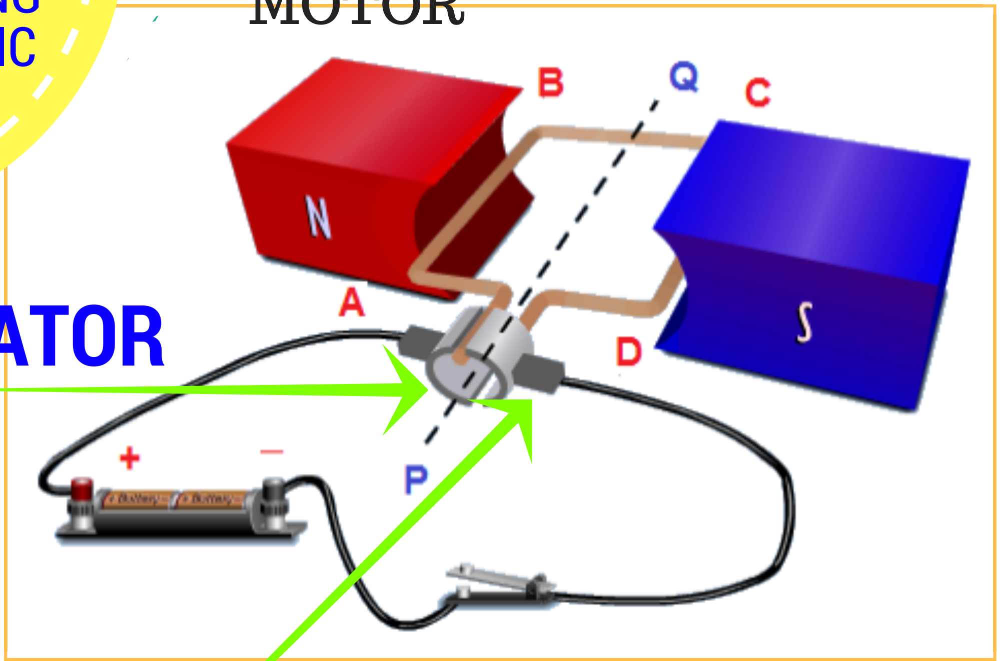
ELECTROMAGNETISME

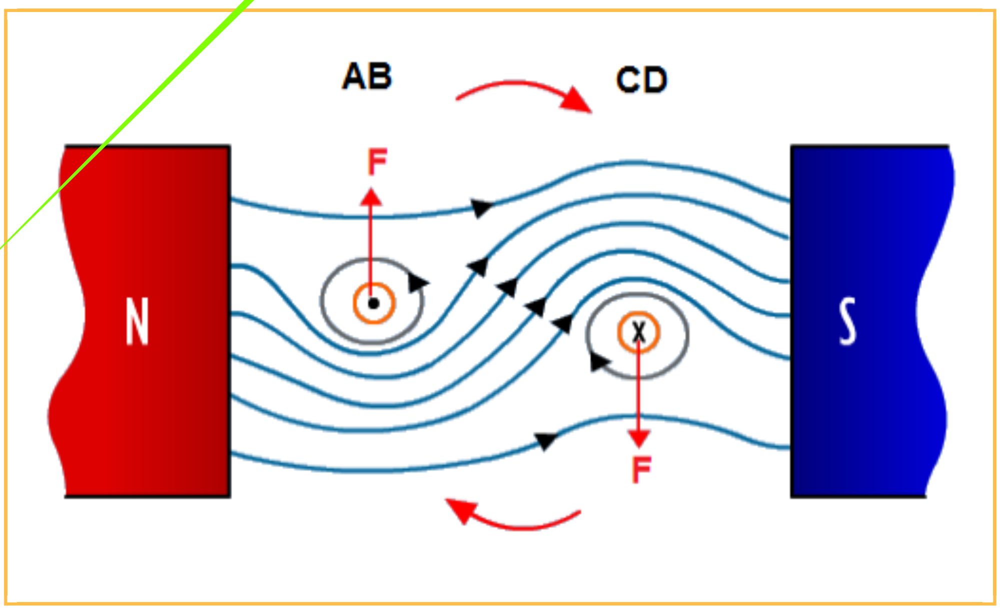
TURNING EFFECT OF A CURRENT-CARRYING COIL IN A MAGNETIC FIELD

DIRECT CURRENT MOTOR



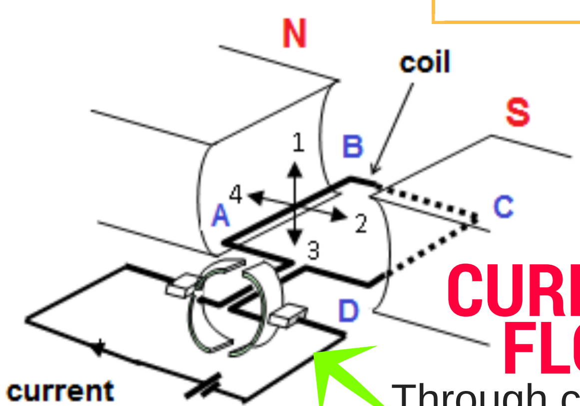
COMMUTATOR

changes the direction of the current flows every **half-cycle**



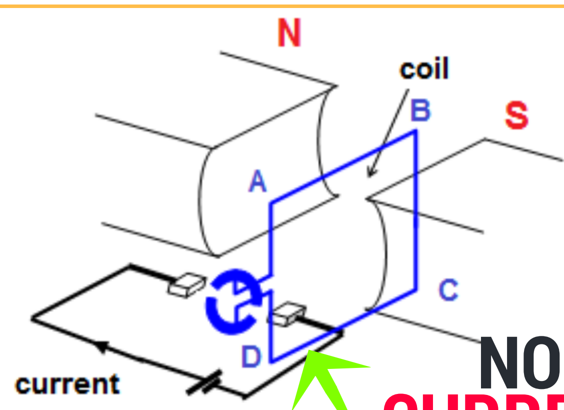
CARBON BRUSH

touch onto the **coil**, to **let the current flow** into and out of the coil



CURRENT FLOW

Through carbon brushes



NO CURRENT FLOW

Circuit broken at carbon brushes

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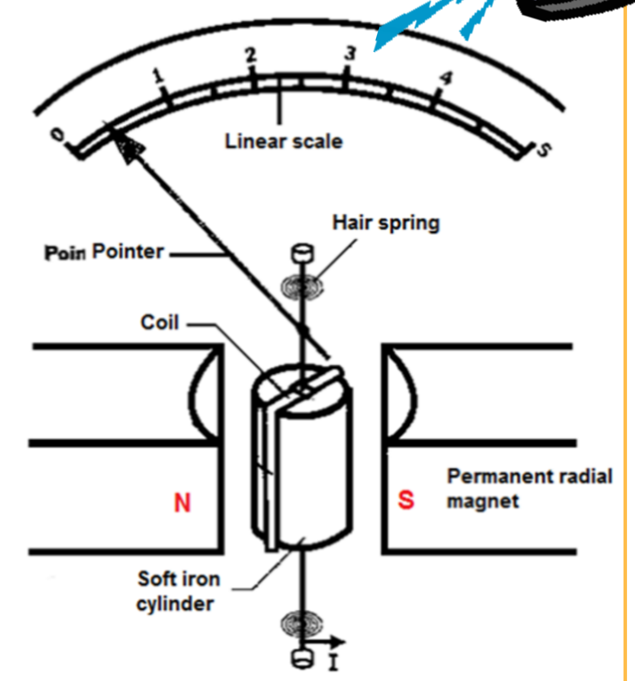
MOVING COIL AMMETER



1. When current flows in moving coil, magnetic field of **radial magnet** will interacts with magnetic field produce by the coil.
2. The **force** acting causes the coil to rotate and lead the pointer to the deflection.
3. The angle of deflection is directly proportional to the current flows in the coil.
4. The hair spring will **restore** the pointer back to its original position.

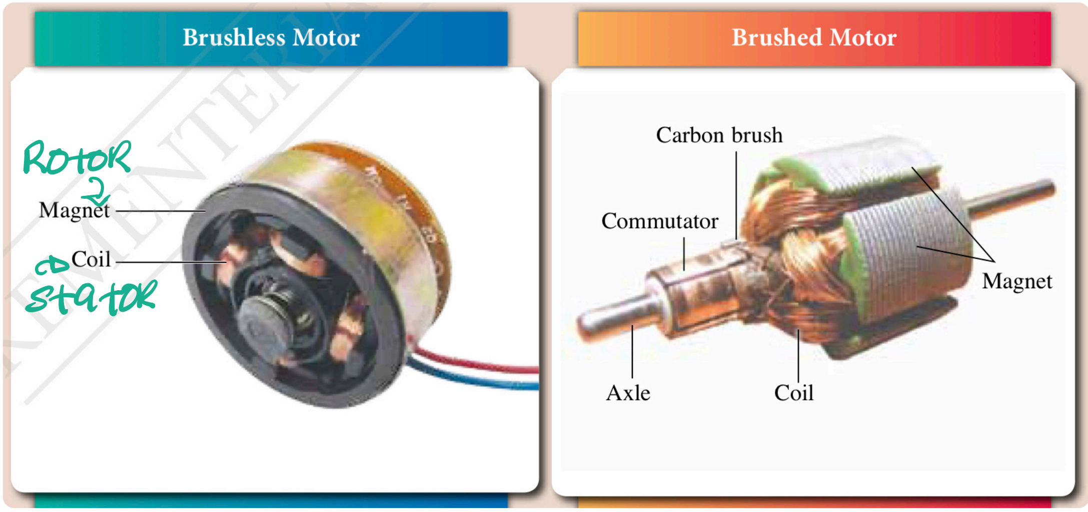
Suitable specifications for the coil and the core to make the galvanometer more efficient.

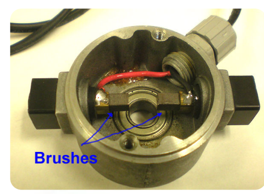
1. Thick wire used for the coil
   - less resistance
2. Use Soft iron core
   - easy to magnetize and demagnetize
3. Larger number of turns of coils
   - the strength of electromagnet increases / stronger magnetic field

TURNING EFFECT on the coil can be increased by

C A T M

C = CURRENT
A = AREA
T = TURNS
M = MAGNET





Brushless motor	Brushed motor
Similarities	
Has a magnet and a coil	
Uses magnetic force to produce rotation	
Differences	
Coil is stationary, magnet rotates	Magnet is stationary, coil rotates
No carbon brushes, therefore no friction between the brushes and the commutator	Friction between the carbon brush and the commutator causes the carbon brush to wear out
No sparking at the commutator	Sparking at the commutator
Soft operational sound	Louder operational noise

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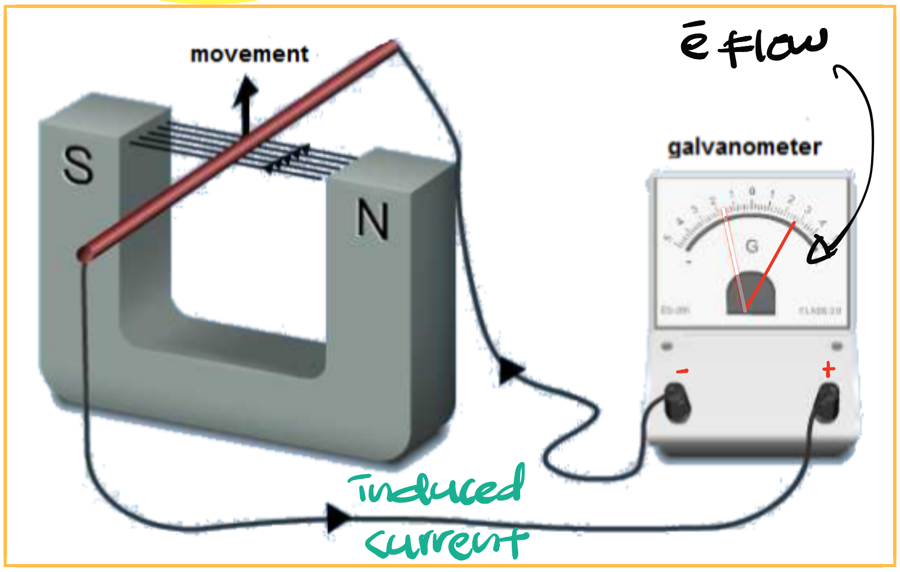
ELECTROMAGNETISME

ELECTROMAGNETIC INDUCTION

galvanometer

to **detect** the **current** flow

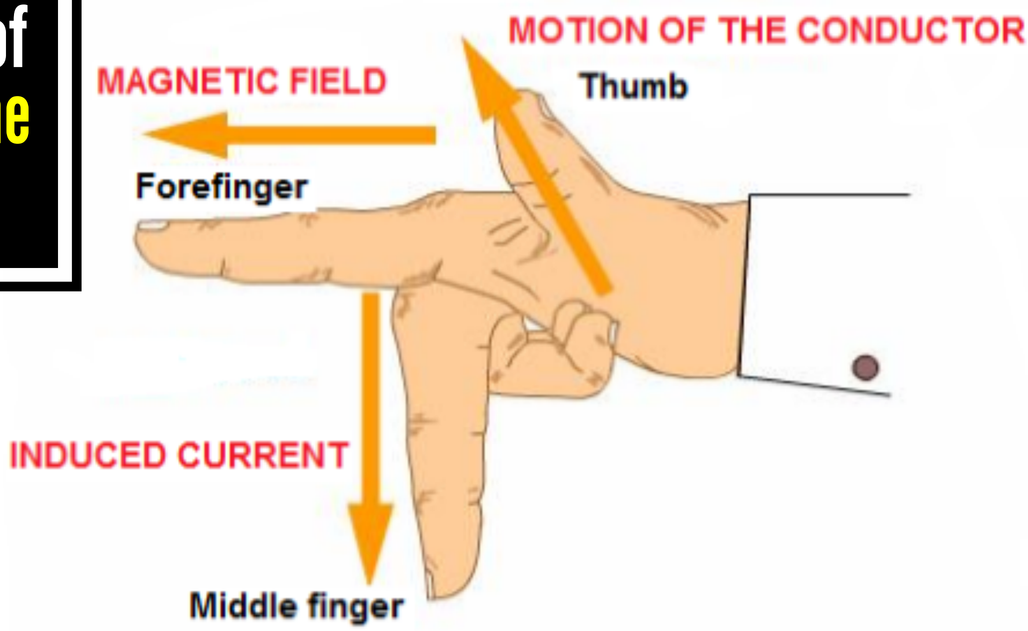


Deflection of the pointer of galvanometer means, there is a **current flow**

Bigger deflection, **larger** current produced

Producing of induced current **when there is a** change or cutting of magnetic flux **by the conductor**

Fleming's Right-Hand Rule



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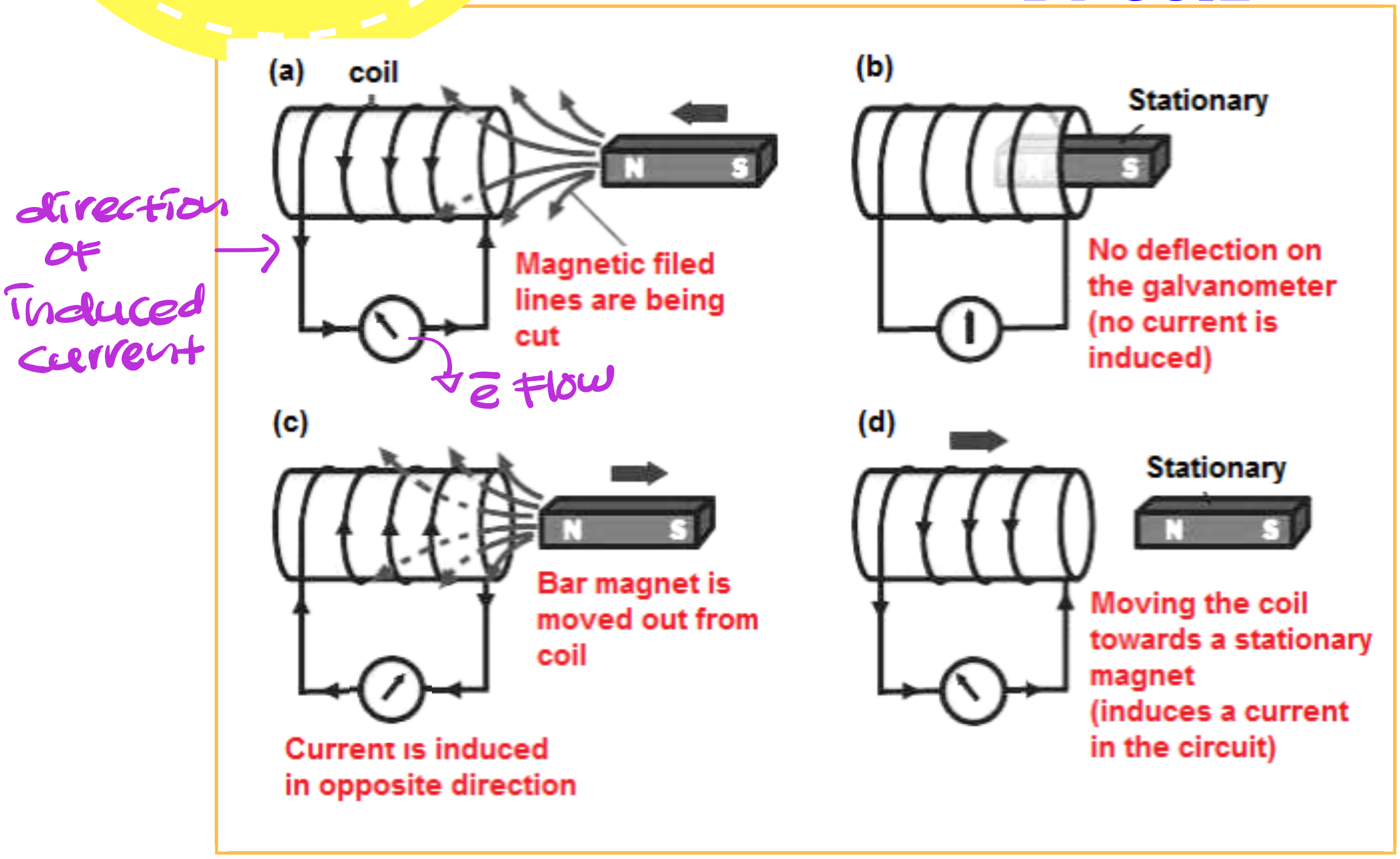
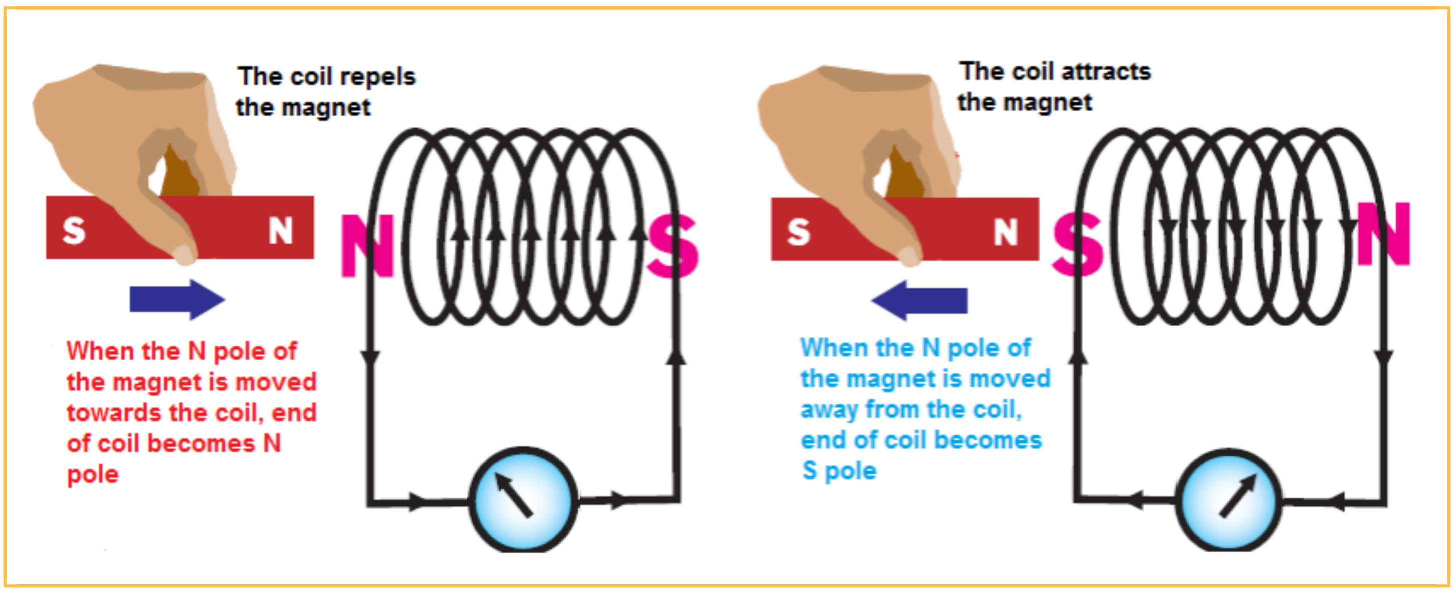
ELECTROMAGNETIC INDUCTION

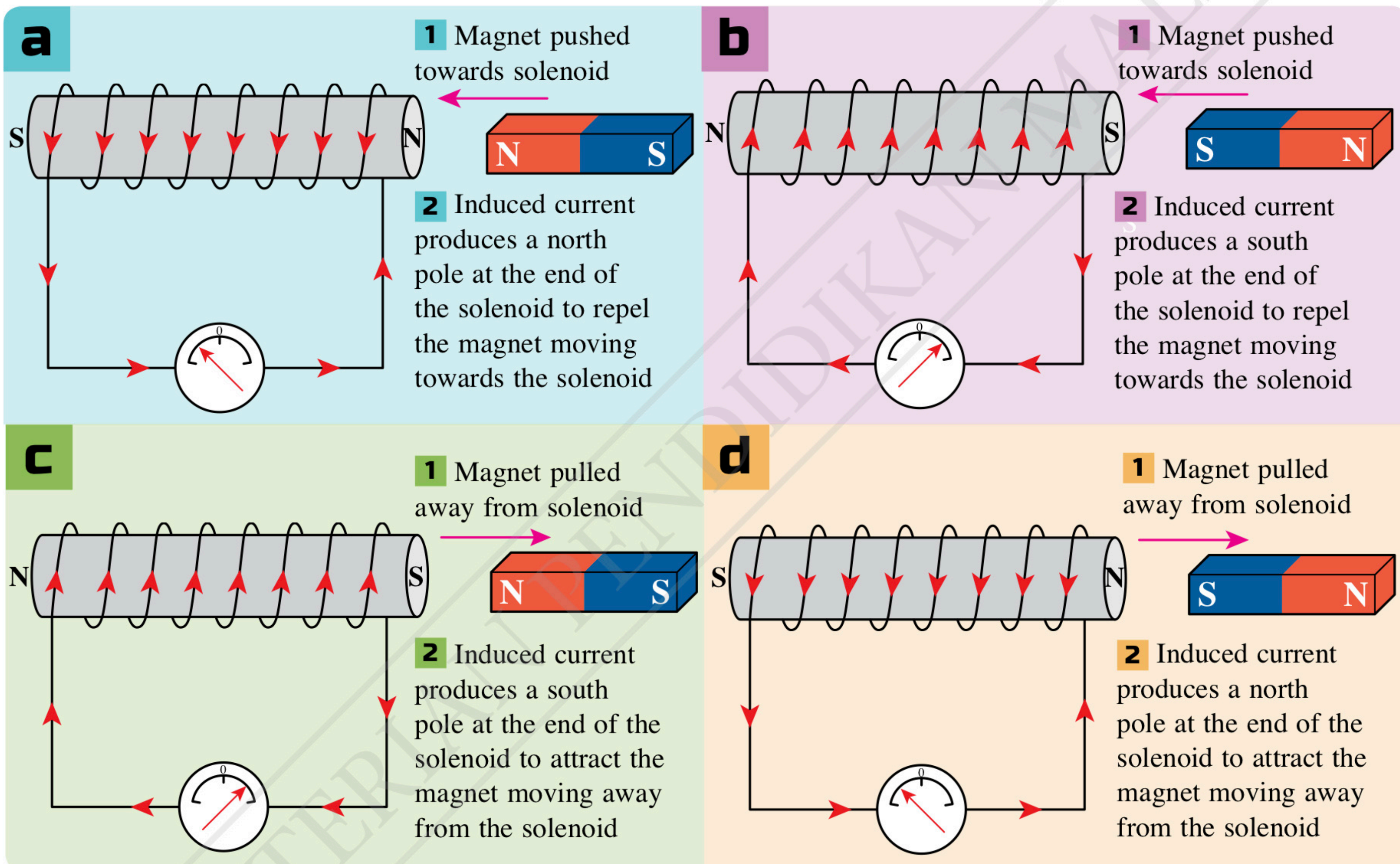
INDUCED E.M.F BY COIL



LENZ'S LAW

the direction of the induced e.m.f is such that its magnetic effects always oppose the change producing it




a
1 Magnet pushed towards solenoid
S
N
N S
2 Induced current produces a north pole at the end of the solenoid to repel the magnet moving towards the solenoid
b
1 Magnet pushed towards solenoid
N
S
S N
2 Induced current produces a south pole at the end of the solenoid to repel the magnet moving towards the solenoid
c
1 Magnet pulled away from solenoid
N
S
N S
2 Induced current produces a south pole at the end of the solenoid to attract the magnet moving away from the solenoid
d
1 Magnet pulled away from solenoid
S
N
S N
2 Induced current produces a north pole at the end of the solenoid to attract the magnet moving away from the solenoid

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ELECTROMAGNETISME

ELECTROMAGNETIC INDUCTION

FARADAY'S LAW

the **magnitude of the induced** e.m.f. is **directly proportional** to the **rate of change of magnetic flux** experienced by the conductor

THE MAGNITUDE OF THE e.m.f IN A wire INCREASES WHEN:

a) The wire is moved faster
b) A stronger magnet is used
c) The length of wire in e.m field is increased

THE MAGNITUDE OF THE e.m.f IN A COIL INCREASES WHEN

a) The relative motion between magnet and coil is increased
b) The number of turns on coil is increased
c) The cross-sectional area of the coil is increased

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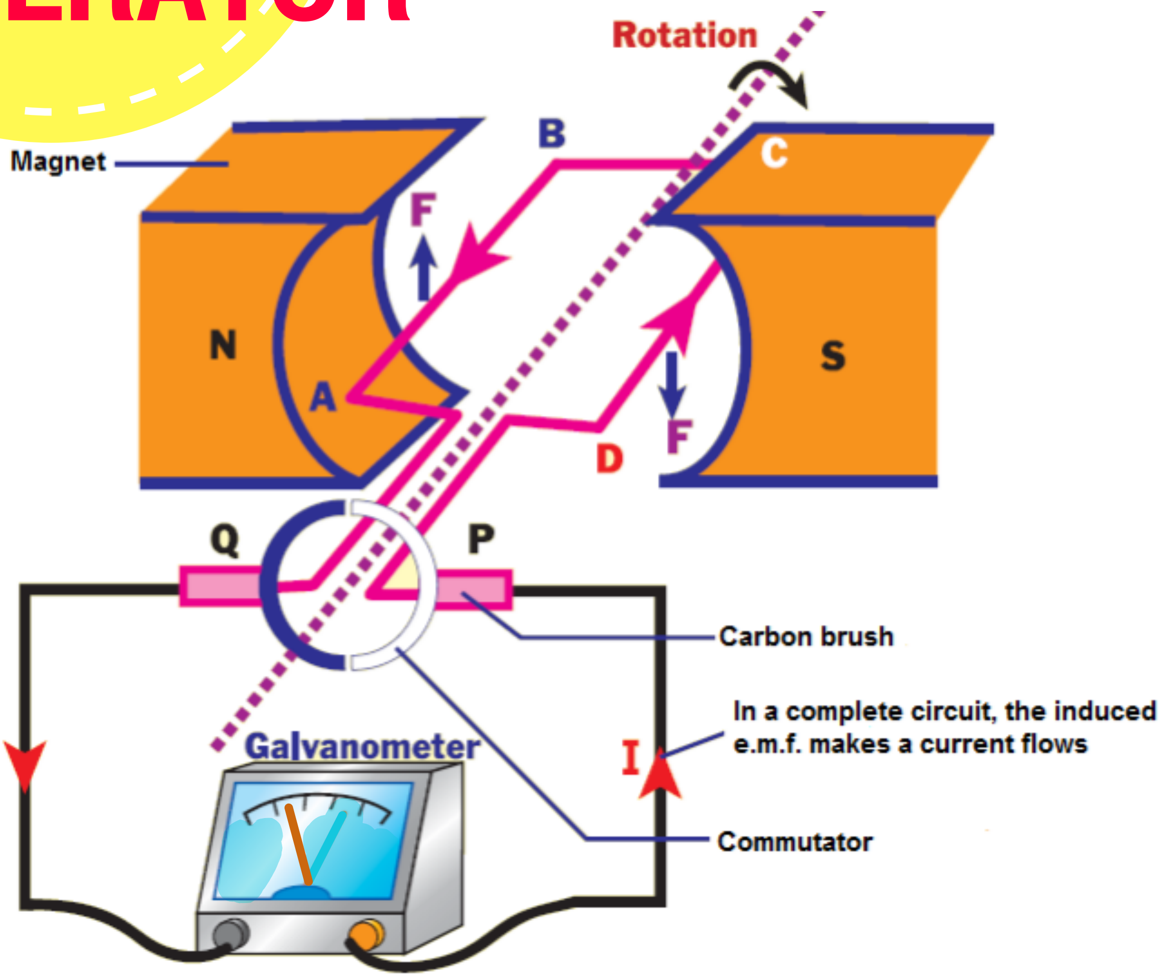
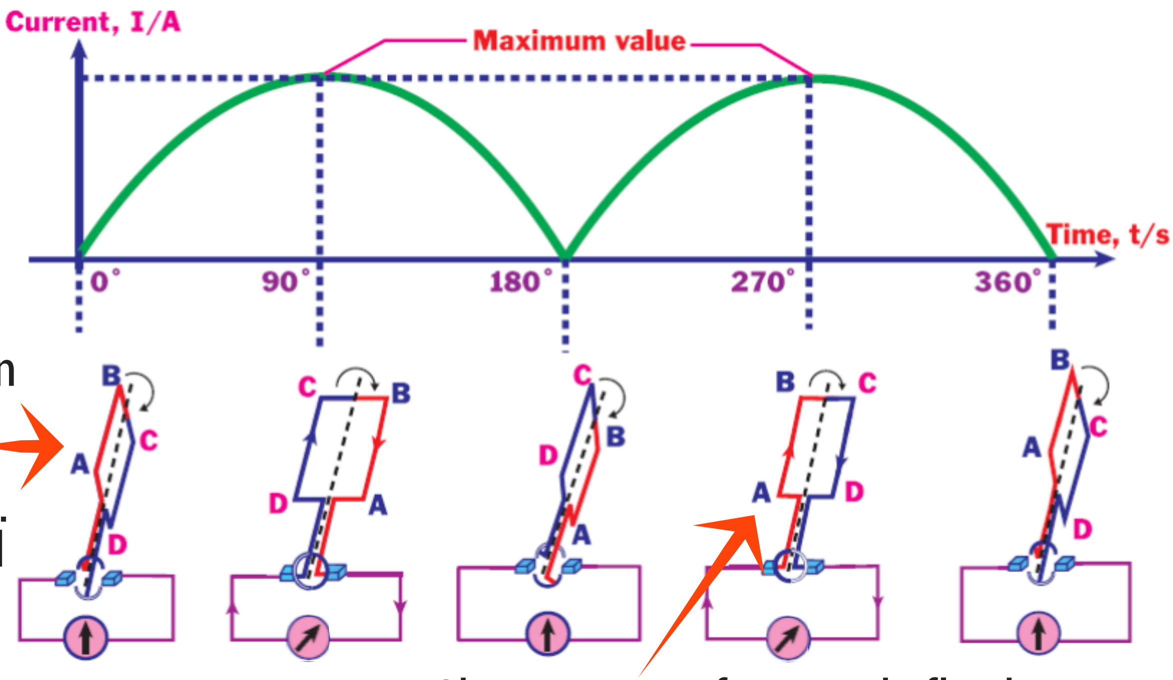
ELECTROMAGNETISME

DC GENERATOR



- No changes in magnetic flux
- No e.m.f. is induced



- Changes rate of magnetic flux is max.
- Induced e.m.f. is max.

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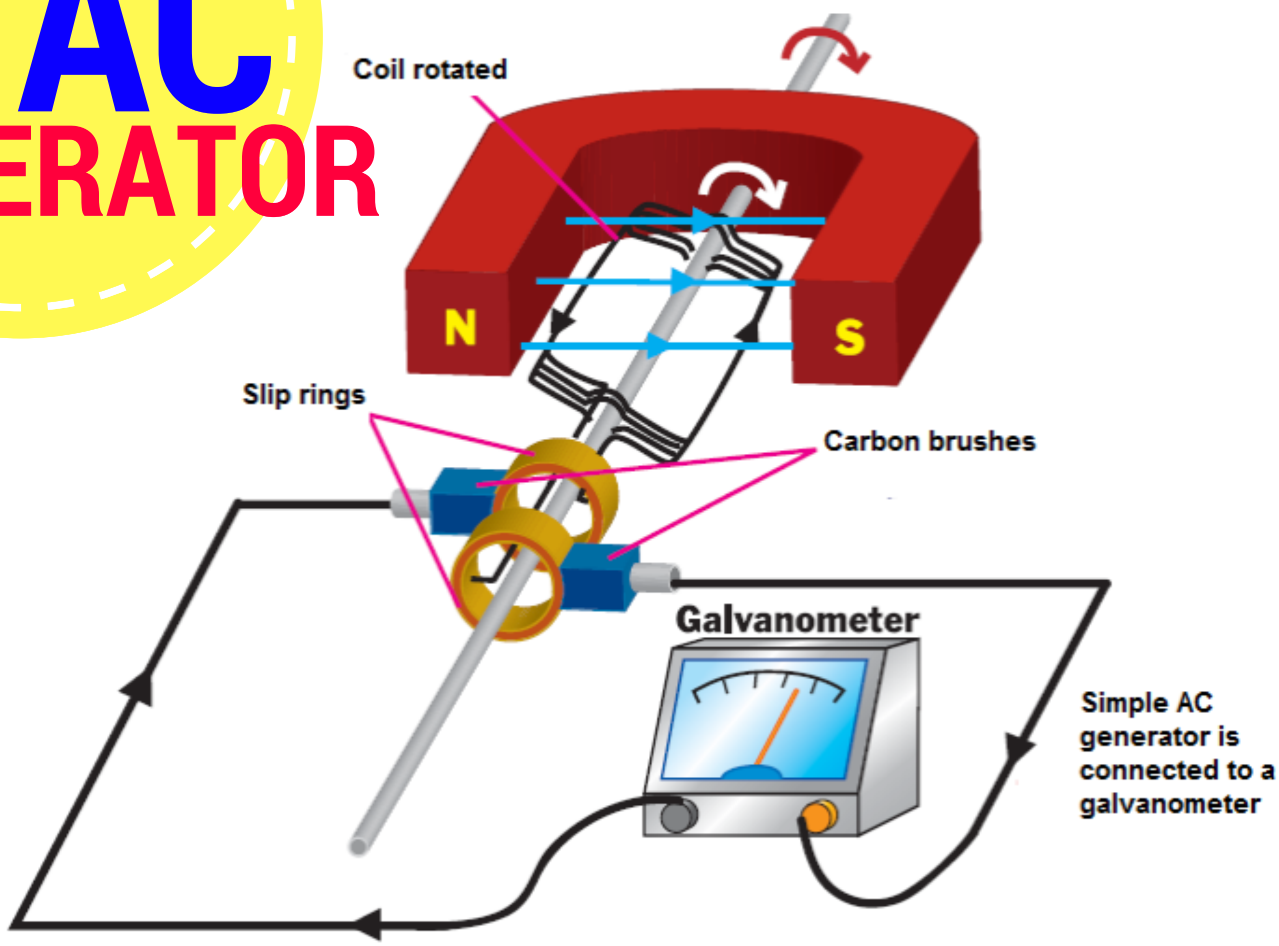
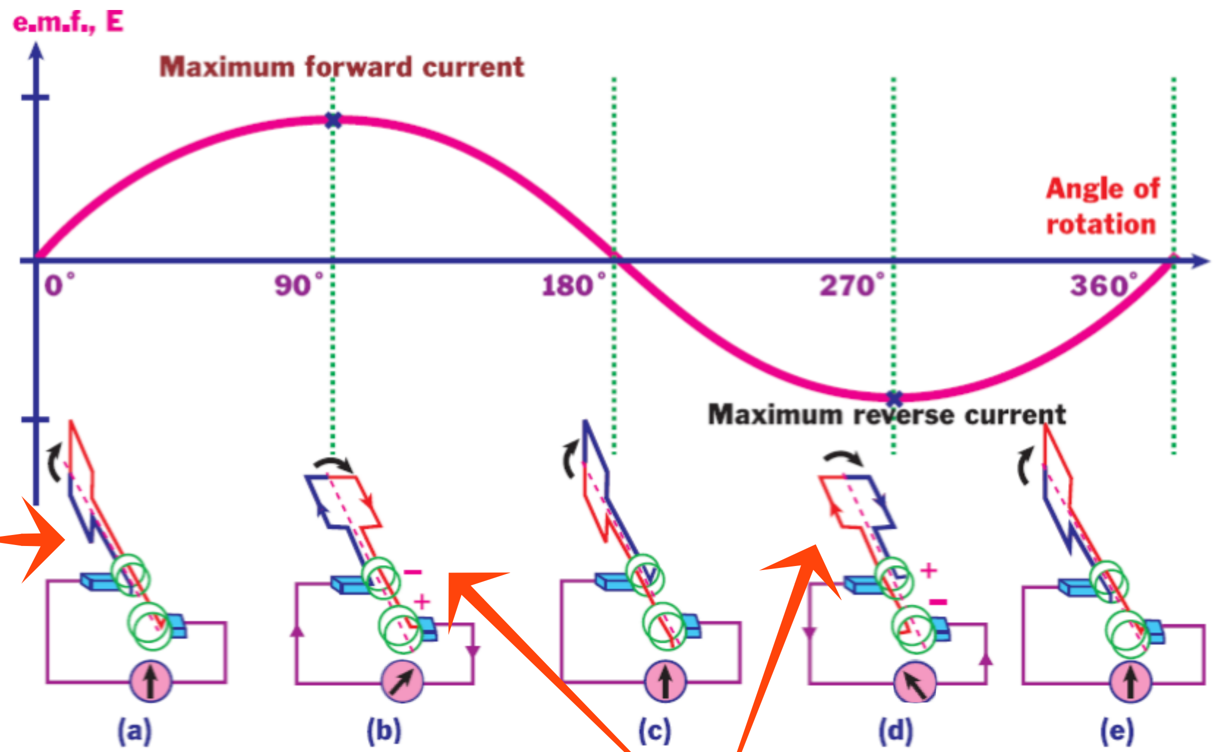
ELECTROMAGNETISME

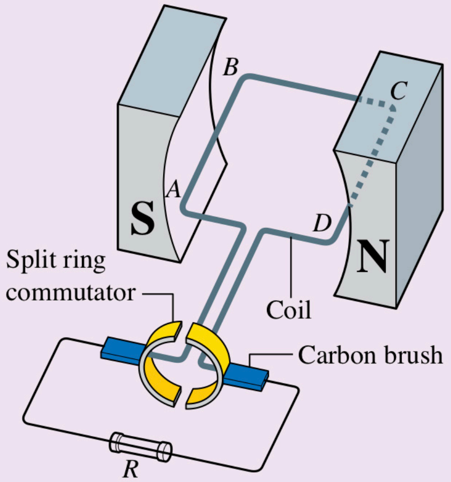
AC GENERATOR



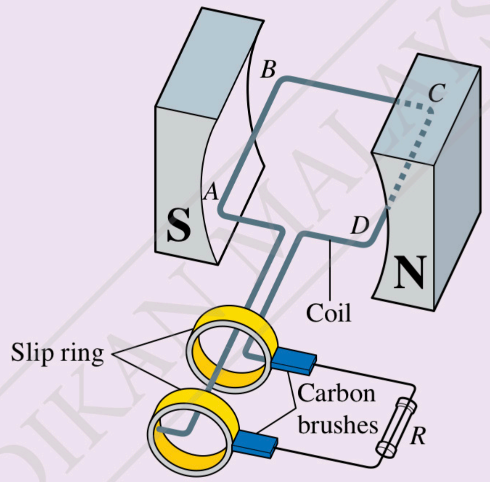


- No changes in magnetic flux
- No e.m.f is induced

- Changes rate of magnetic flux is max.
- Induced e.m.f. is max.



(a) Direct current generator



(b) Alternating current generator

Direct current generator	**Alternating current generator**
Similarities	
Applies electromagnetic induction	
Coil is rotated by an external force	
Coil cuts magnetic flux	
e.m.f. is induced in the coil	
Differences	
Ends of the coil are connected to a split ring commutator	Ends of the coil are connected to two slip rings
The two sections of the commutator exchange contact with the carbon brush every half rotation	Slip rings are connected to the same carbon brush
Output is direct current	Output is alternating current

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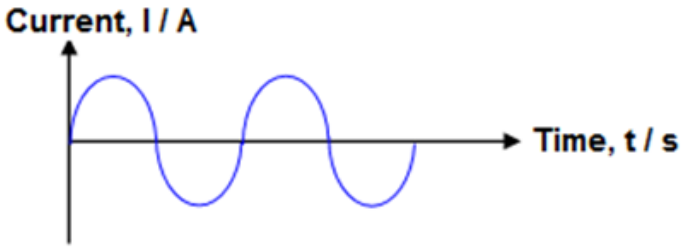
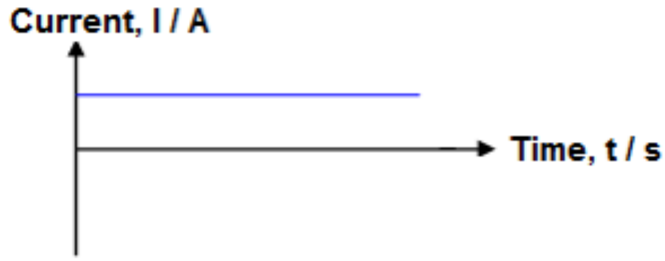
CHAPTER 3

ELECTROMAGNETISME

AC current *versus* DC current

Graphs



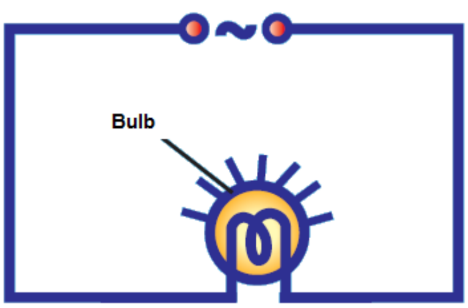


Direction

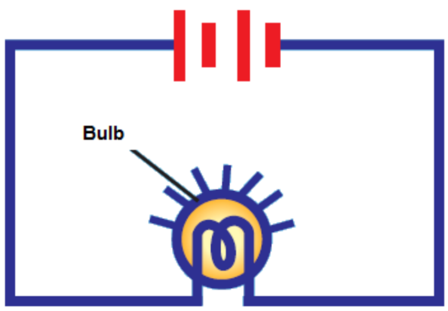
AC current:
* Variable
* Current flow in **two** direction

DC current:
* Constant
* Current flow in **one** direction

Effects on bulb

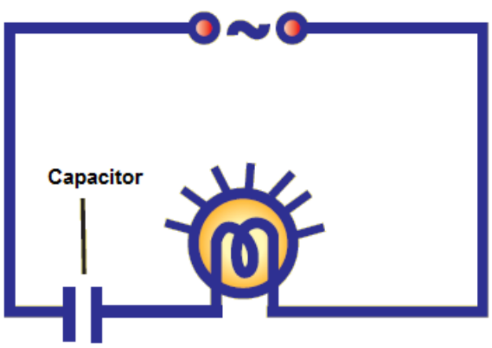


The bulb **lights up**

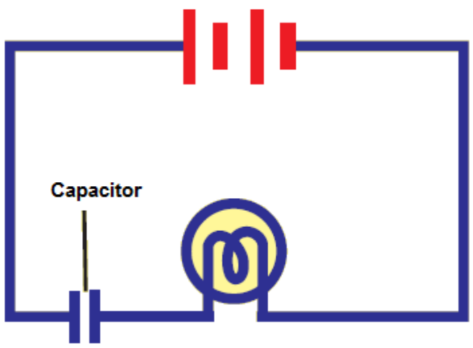


The bulb **lights up**

Effects on capacitor



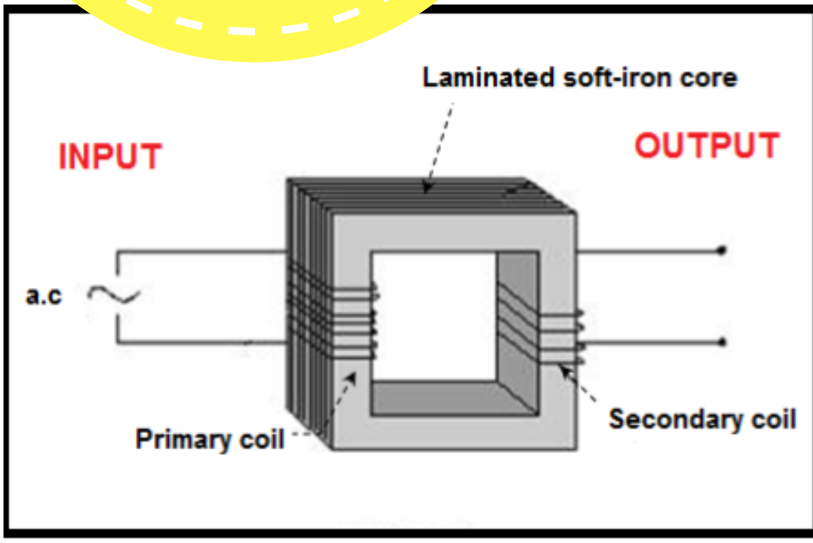
Capacitor **works on** alternating current

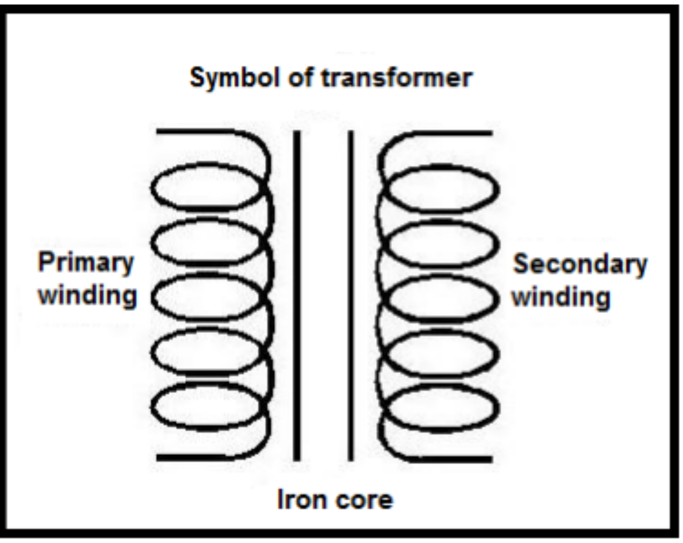


Capacitor will **not** work on direct current

TRANSFORMERS

electrical device which increases or decreases an alternating voltage based on the principle of electromagnetic induction





Working principle of the transformer:

- Alternating current flows in the primary coil induces a magnetic field in the soft iron core
- The magnetic field is constantly changing
- The secondary coil also experienced magnetic flux linkage which is constantly changing
- Hence an alternating e.mf. is induced in the secondary coil

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ELECTROMAGNETISME

TRANSFORMERS

Input & output of a transformer

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

a. Ideal transformer

$$V_p I_p = V_s I_s$$

b. Non-Ideal transformer

$$\text{Efficiency} = \frac{V_s I_s}{V_p I_p} x100\%$$

Energy losses in a transformer

TYPE OF LOSSES	CAUSES	WAY TO REDUCE
Eddy current	• Changing of magnetic field induced current in soft iron core • Eddy current produced and generate heat	• **Use laminated soft iron core**
Heat loss	• As the number of turn increases, the resistance of conductor also increases. • Heat produced by electrical energy to oppose the resistance	• **Use low resistance copper wires (thick copper wire)**
Hysteresis	• The core is magnetized and demagnetized alternately due to a.c current in primary coil • Energy loss as heat	• **Use soft-iron core** • **It is able to be magnetized and demagnetized easily**
Flux leakage	• **Leakage of magnetic flux in the primary coil**	• **Proper core design** • **Secondary coil overlaps and wounds close to primary coil**

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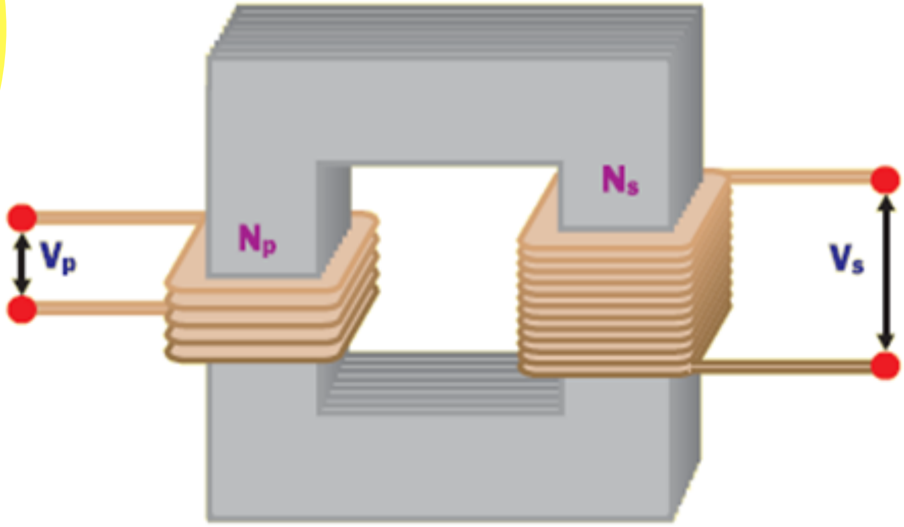
TRANSFORMERS

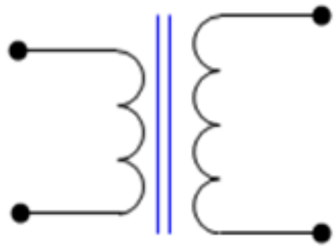


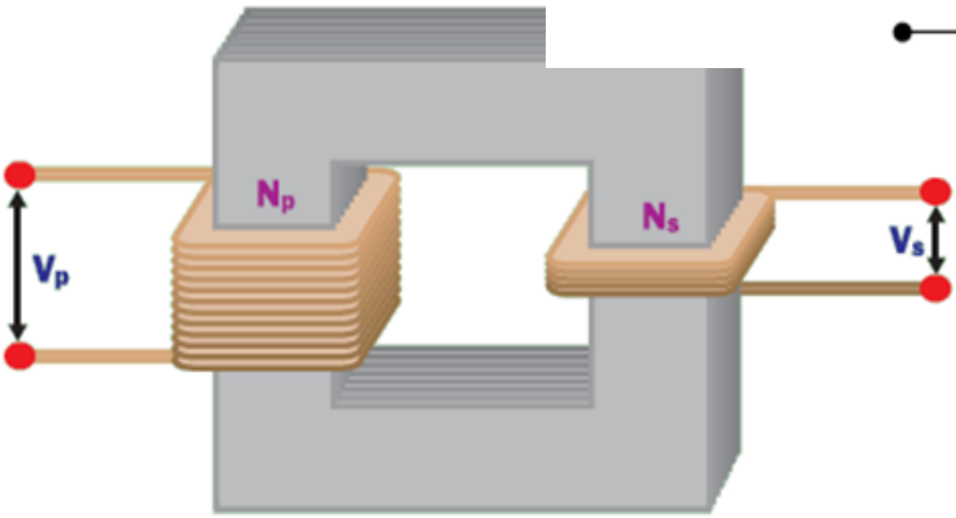
step-up transformer

(a) $N_p < N_s$

(b) $V_p < V_s$

(c) $\frac{N_s}{N_p} = \frac{V_s}{V_p}$



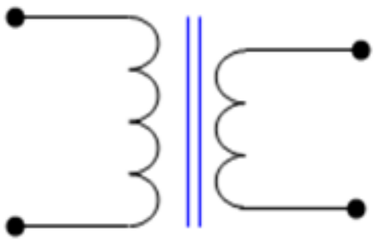


(a) $N_p > N_s$

(b) $V_p > V_s$

(c) $\frac{N_s}{N_p} = \frac{V_s}{V_p}$

step-down transformer



Extra!

using RIGHT HAND GRIP RULE

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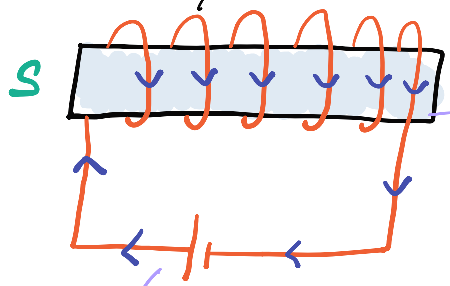


Rule to determine the pole of solenoid: RIGHT HAND GRIP RULE

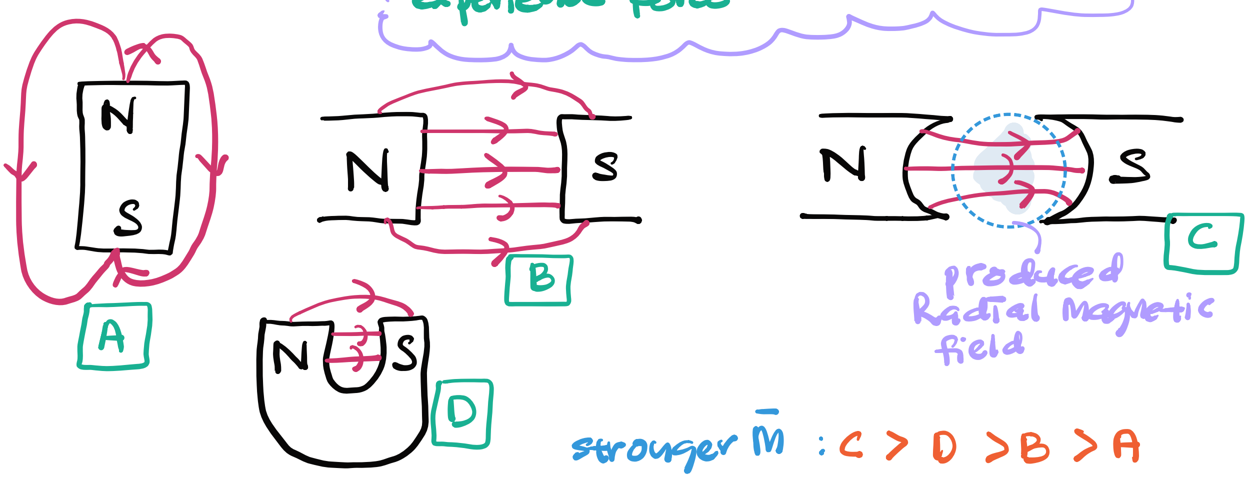
soft iron core
- easy to magnetised and demagnetised

when current flow → become ELECtromagnet
- temporary magnet when current flow through the conductor

How to increase the ELECtromagnet?

- no. of turns ↑ ⇒ more current flow // stronger EM
- no. of dry cells ↑ ⇒ increase the current
- thicker wire ⇒ less resistance
- soft iron core ⇒ easy to magnetised + demagnetised

Magnetic field ⇒ a Region where magnetic material experience force

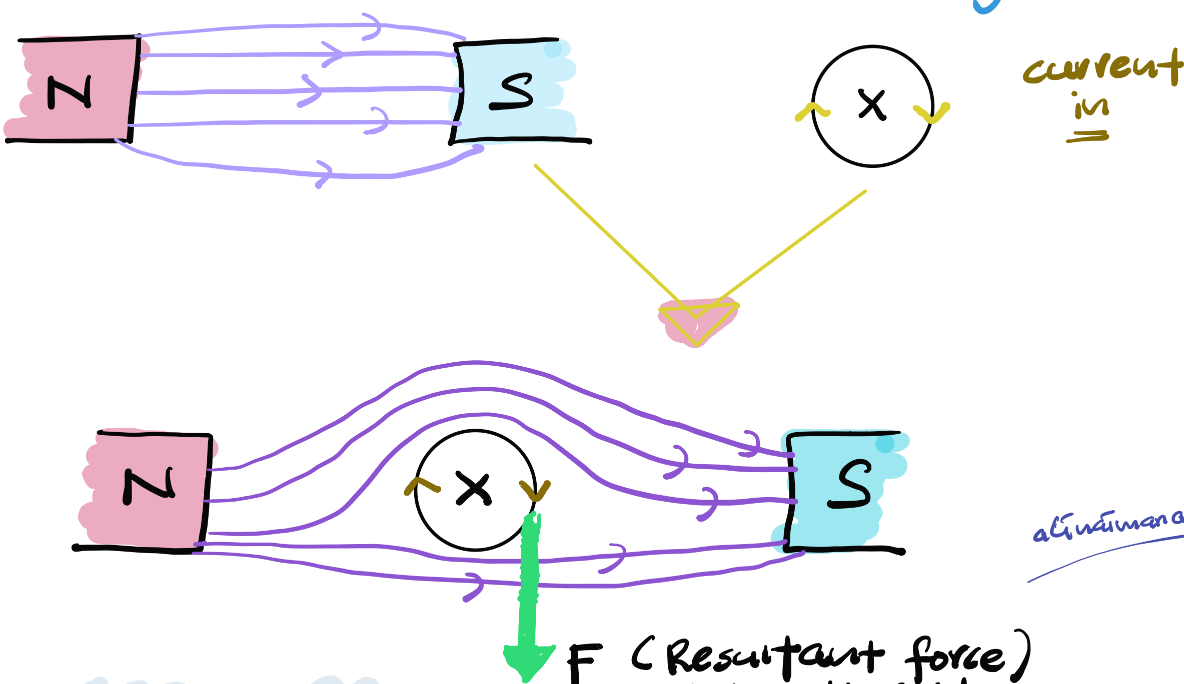


stronger M̄ : C > D > B > A

Catapult field : combination of magnetic field between current carrying conductor and magnetic field in permanent magnet

① $\bar{M}$ in permanent magnet :

② $\bar{M}$ in current carrying conductor:



F (Resultant force)
- catapult field

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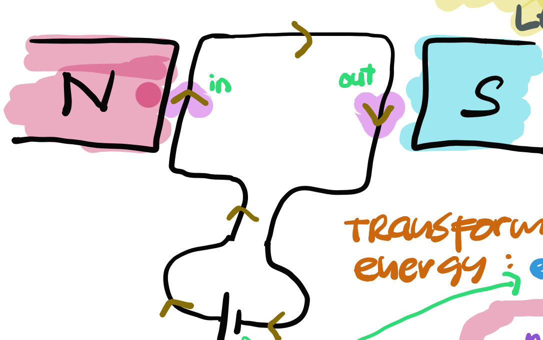
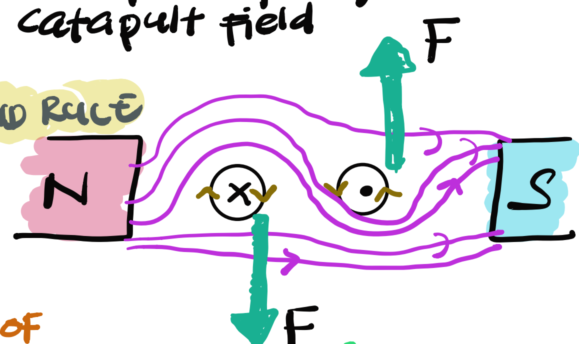
MOTOR ELECTRIC

FLEMING'S LEFT HAND RULE





Transformation of energy : electric → kinetic - rotation

How to increase the speed of rotation of the motor?

- no. of dry cells ↑ → more current flow
- no. of turns ↑ → increase current → more change in $\bar{M}$ → stronger $\bar{M}$
- curve magnet → stronger $\bar{M}$ → radial $\bar{M}$
- no. of magnet ↑ → strength of $\bar{M}$ ↑

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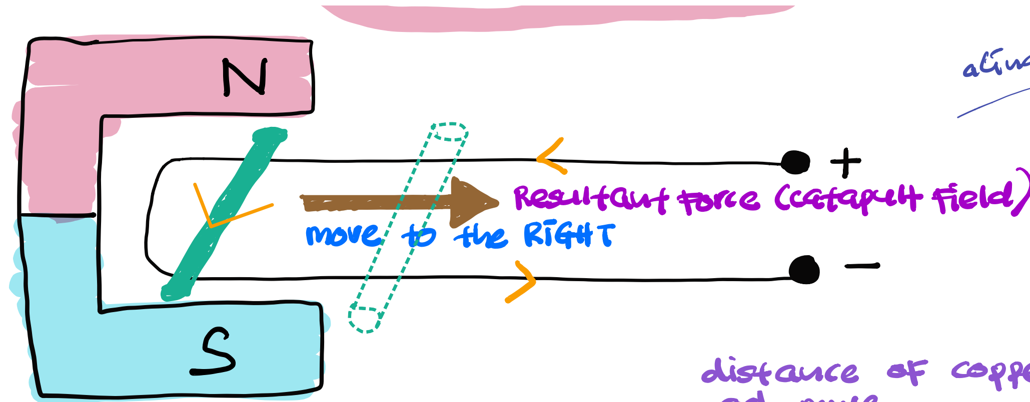


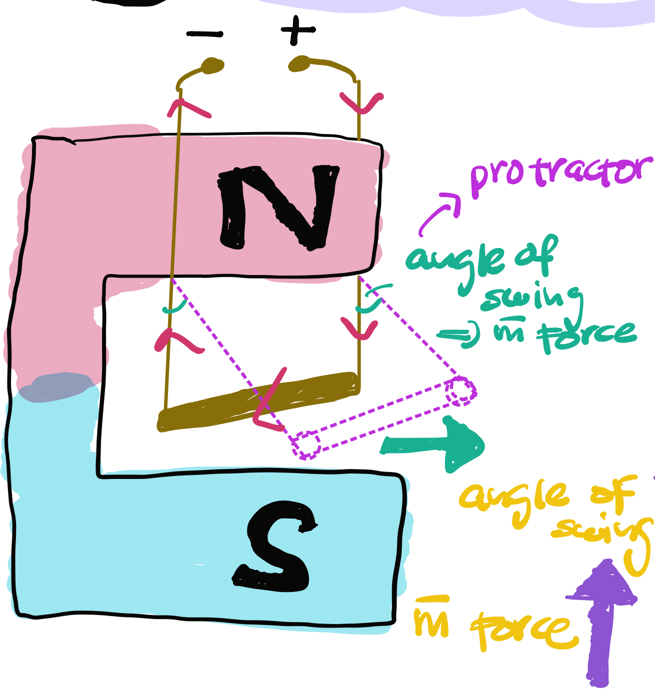
distance of copper rod move
→ magnetic force
physical quantity

Idea + concept

1
mv : current
rv : distance of copper rod move
cv : no. of magnet // distance of magnet

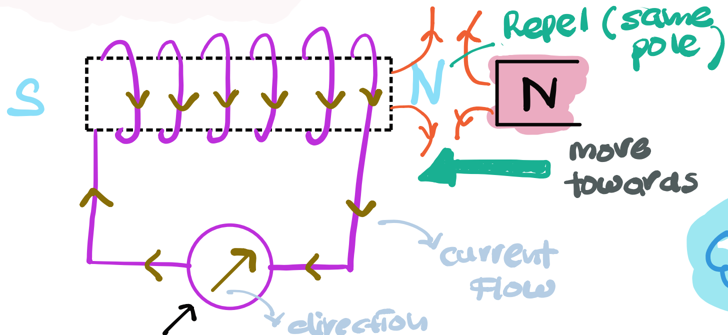
2
mv : no. of magnet
Rv : distance of copper rod move
cv : current // distance of magnet

3
mv : distance of magnet
Rv : distance of copper rod move
cv : current // no. of magnet



meter rule
distance of copper rod move
m̄ force

electromagnetic INDUCTION: — producing of induced current when there is a change in $\overline{M}$

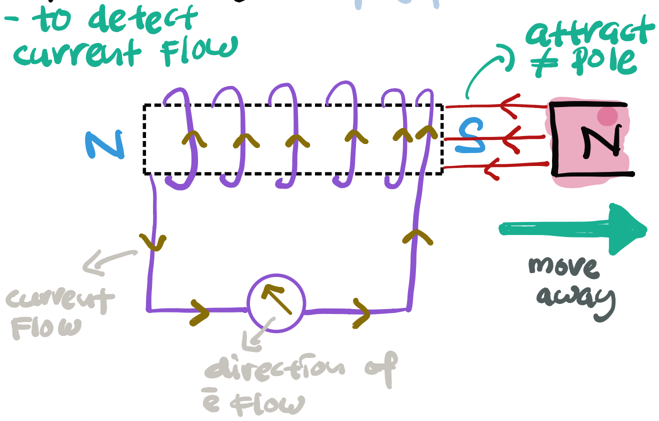


Galvanometer
- to detect current flow

Lenz's Law
- to determine the pole of the solenoid

IDEA

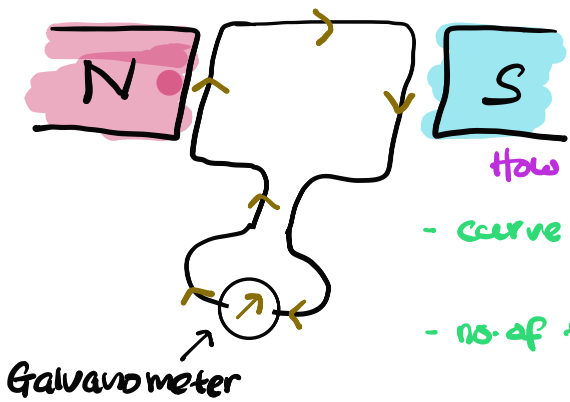
towards – repel
away – attract



How to increase the induced current?

- no. of turns ↑
  ⇒ more induced I flow
- thicker wire
  ⇒ R ↓
- relative motion ↑
  ⇒ more change in $\overline{M}$
  ⇒ induced I increase

Faraday's Law magnitude of induced I ∝ to the change of $\overline{M}$



transformation of energy:

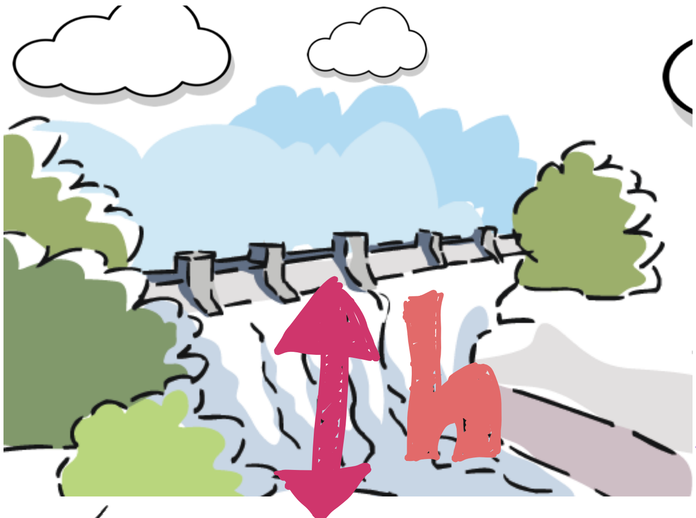
kinetic → electric

concept: GENERATOR

How to increase the speed of rotations?

- curve magnet ⇒ radial $\overline{M}$
  ⇒ stronger $\overline{M}$
- no. of turns ↑ ⇒ more induced I
  ⇒ more change in $\overline{M}$
- thicker wire ⇒ R↓ // more induced I
- no. of magnet ↑ ⇒ more $\overline{M}$
  ⇒ stronger $\overline{M}$

aliyatimanarif...



(transformation of energy:

gravitational potential energy + kinetic + electric

GENERATOR

$$mgh = \frac{1}{2} mv^2$$

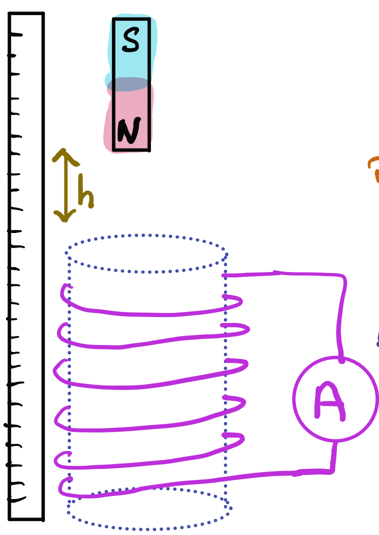
$$v^2 = 2gh$$

$$v = \sqrt{2gh}$$ — speed ⇒ kinetic energy ⇒ speed of rotation

↳ height of magnet bar released (h)

↑ physical quantity

h ↑ induced current ↑



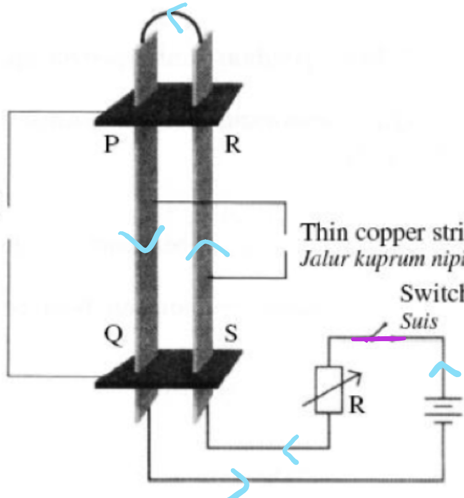
↙ deflection of ammeter

How to increase the induced I?

- Increase h
- no. of turns ↑
- no. of magnet ↑
- thicker wire

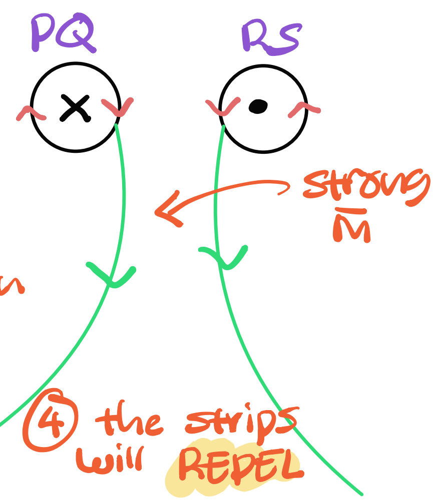
alifandimanarif

1



(1) switch ON current flow at **opposite** direction

(2) direction of $\bar{M}$ same



(3) strong $\bar{M}$ between PQ and RS

(4) the strips will **REPEL**

2

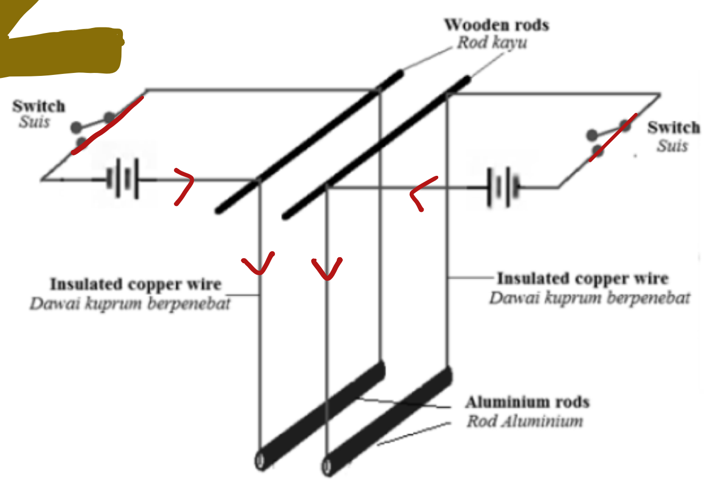
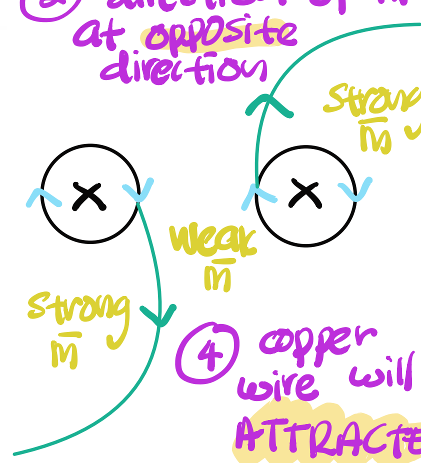


Diagram 4

(1) switch ON current flow at **same** direction

(2) direction of $\bar{M}$ at **opposite** direction



(3) weak $\bar{M}$ between the copper wire

(4) copper wire will **ATTRACTED**

afiqahaimanarif