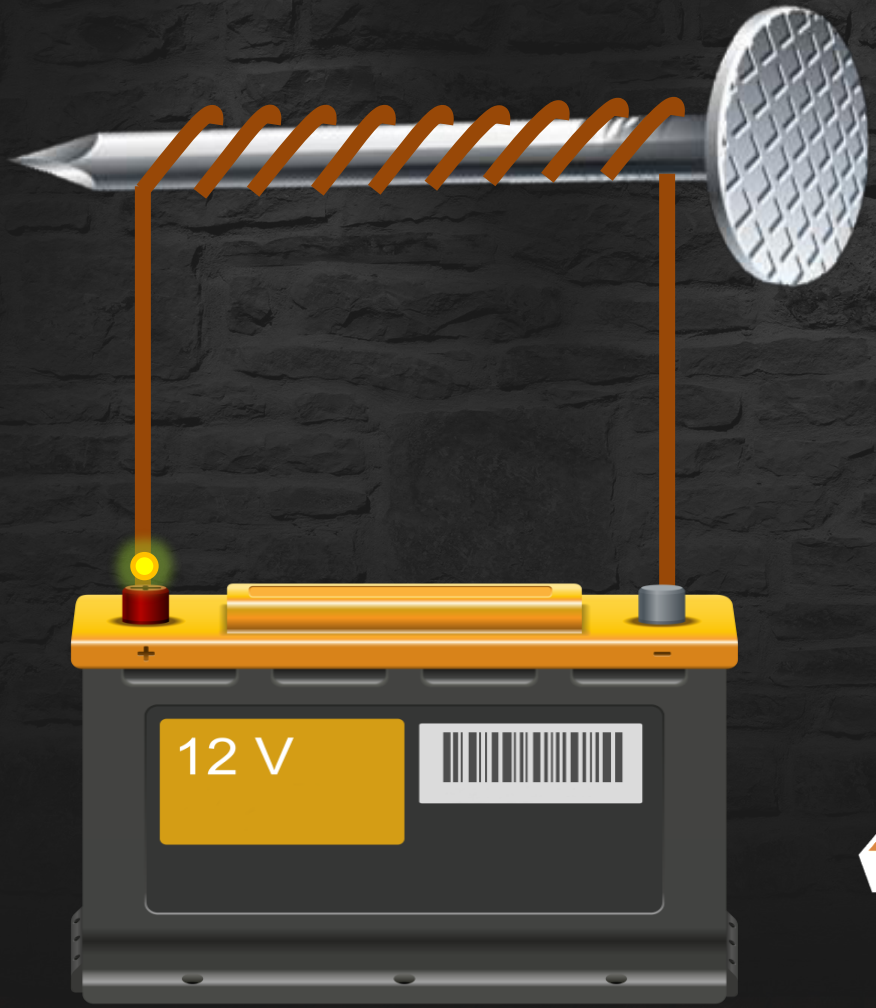
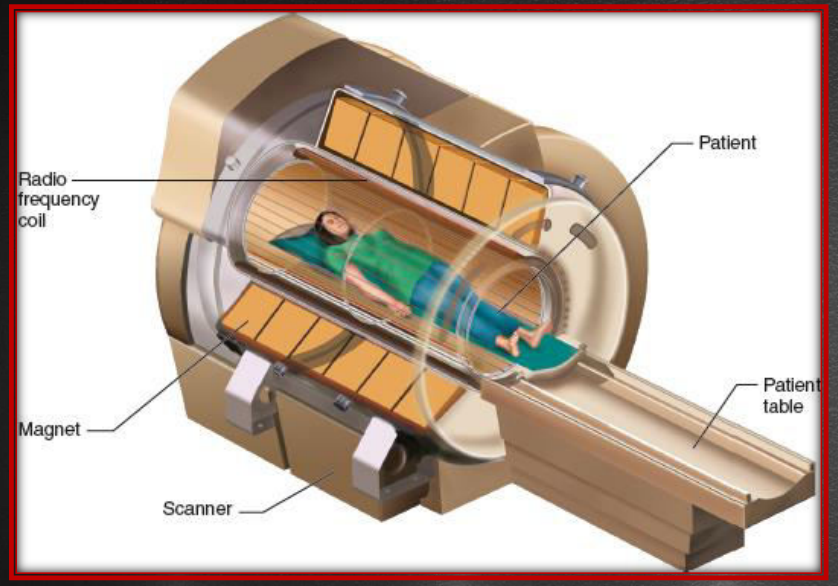
LECTURE 1

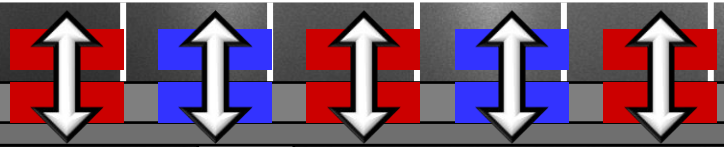


MAGNETIC EFFECTS OF ELECTRIC CURRENT

MRI Machine

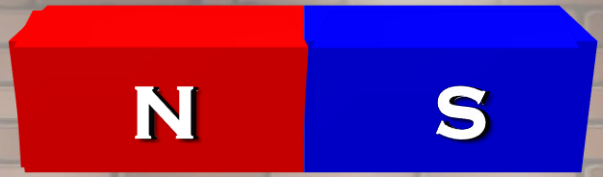


Speaker



A small state in Greece

Ancient Chinese found this stone
When suspended, always points in north - south direction
It was used for navigation.

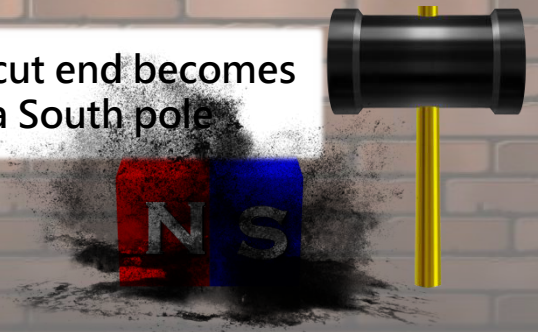


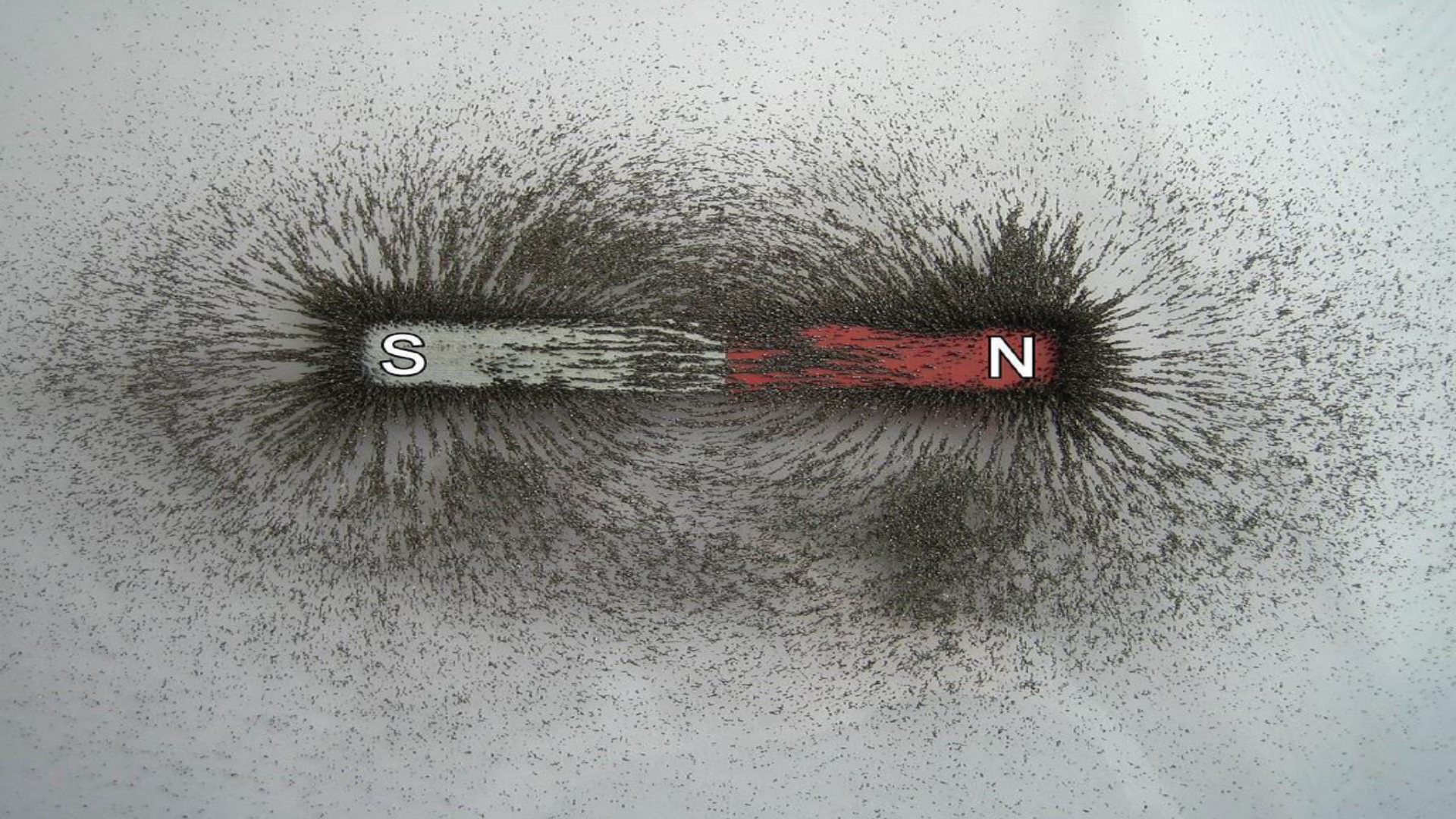
A magnet is always dipole

BAR MAGNET

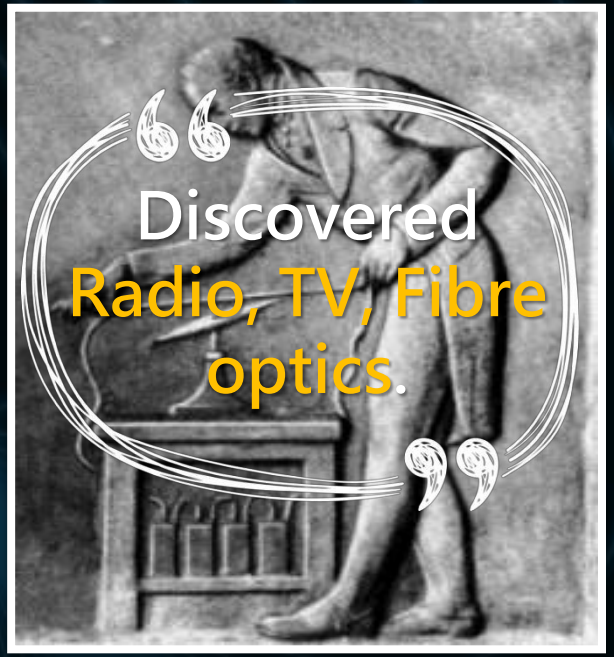
One cut end becomes a North pole

One cut end becomes a South pole




S
N

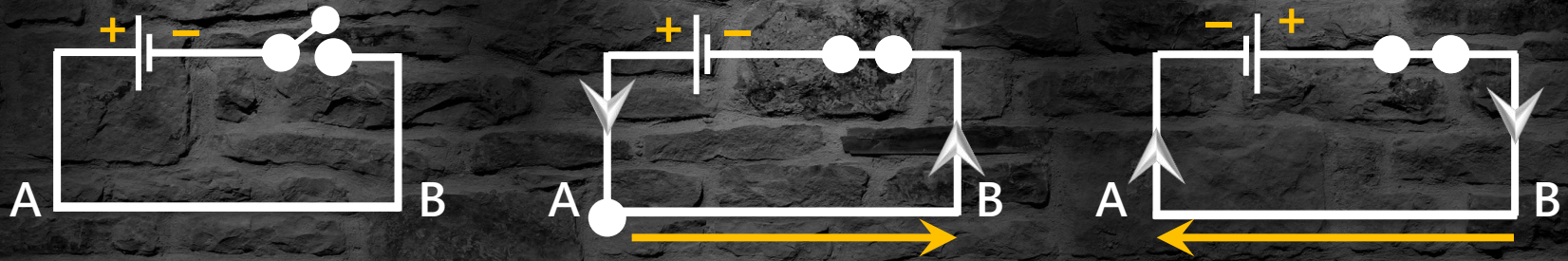
Magnetic Effect Of Electric Current

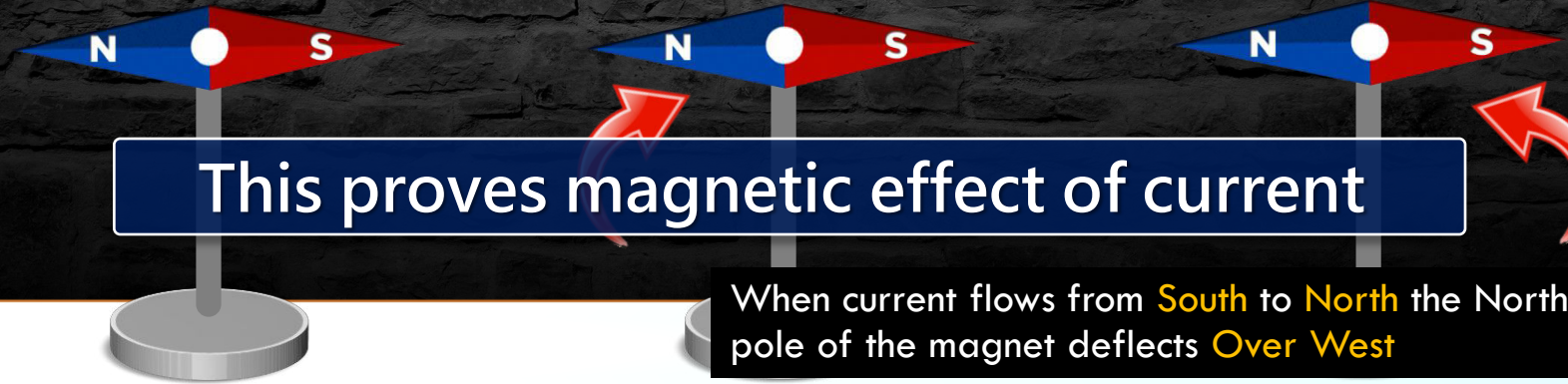


HANS CHRISTIAN OERSTED (1820)

Magnetic Effect Of Electric Current

SNOW

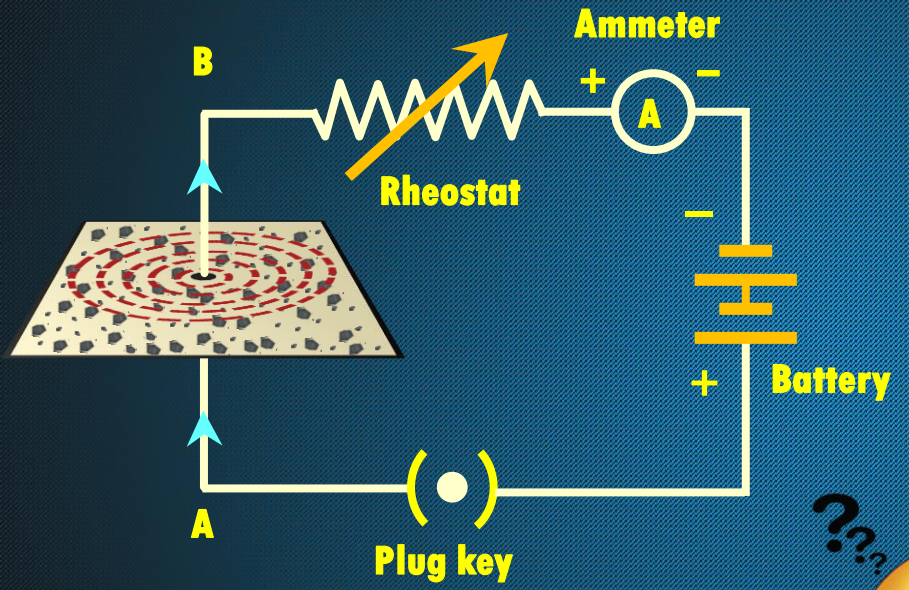




This proves magnetic effect of current

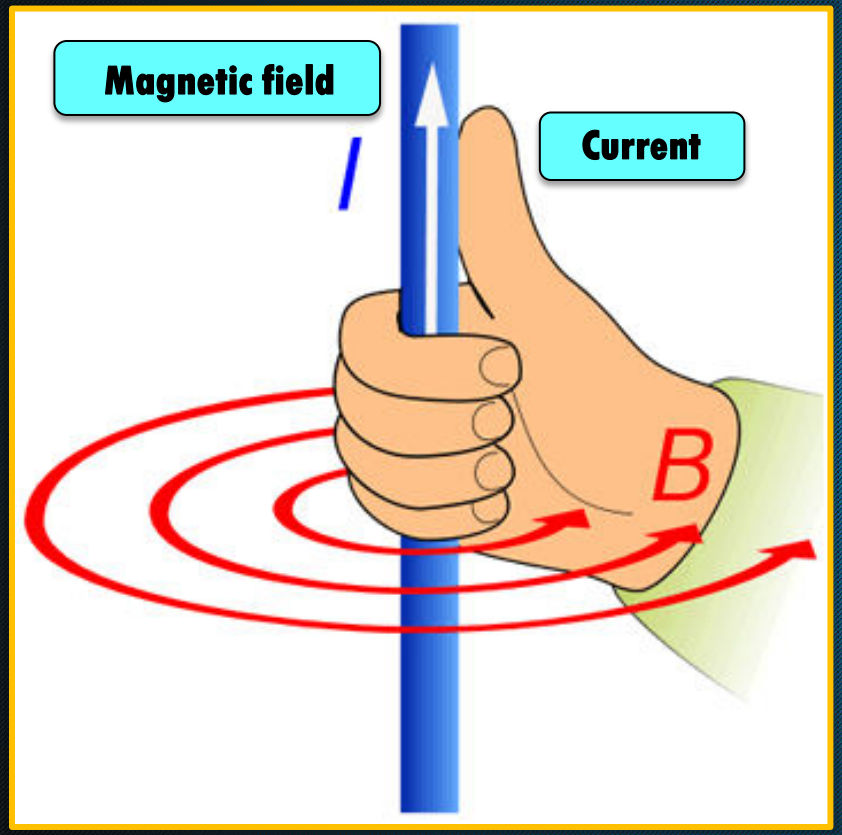
When current flows from South to North the North pole of the magnet deflects Over West

MAGNETIC FIELD FOR A STRAIGHT CONDUCTOR



How to find direction of magnetic field ?

MAGNETIC FIELD FOR A STRAIGHT CONDUCTOR

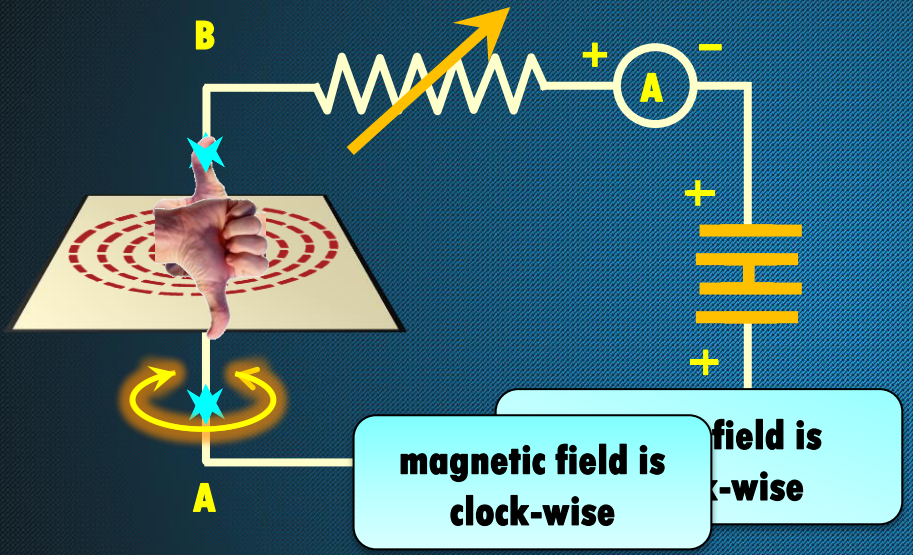


RIGHT HAND THUMB RULE

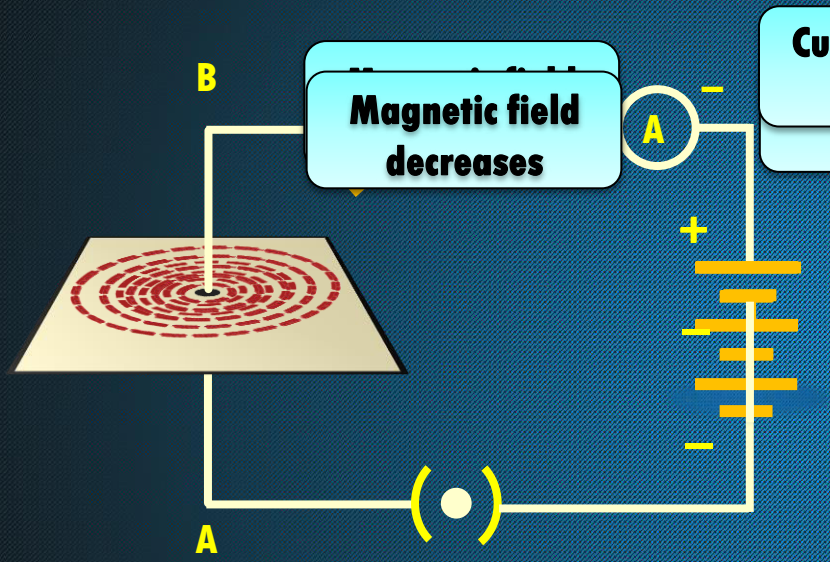
Imagine that you have held the conductor in your right hand in such way that your thumb points in the direction of the current.

Then turn your fingers around the conductor, the direction of the fingers is the direction of the magnetic lines of force.

MAGNETIC FIELD FOR A STRAIGHT CONDUCTOR



MAGNETIC FIELD FOR A STRAIGHT CONDUCTOR



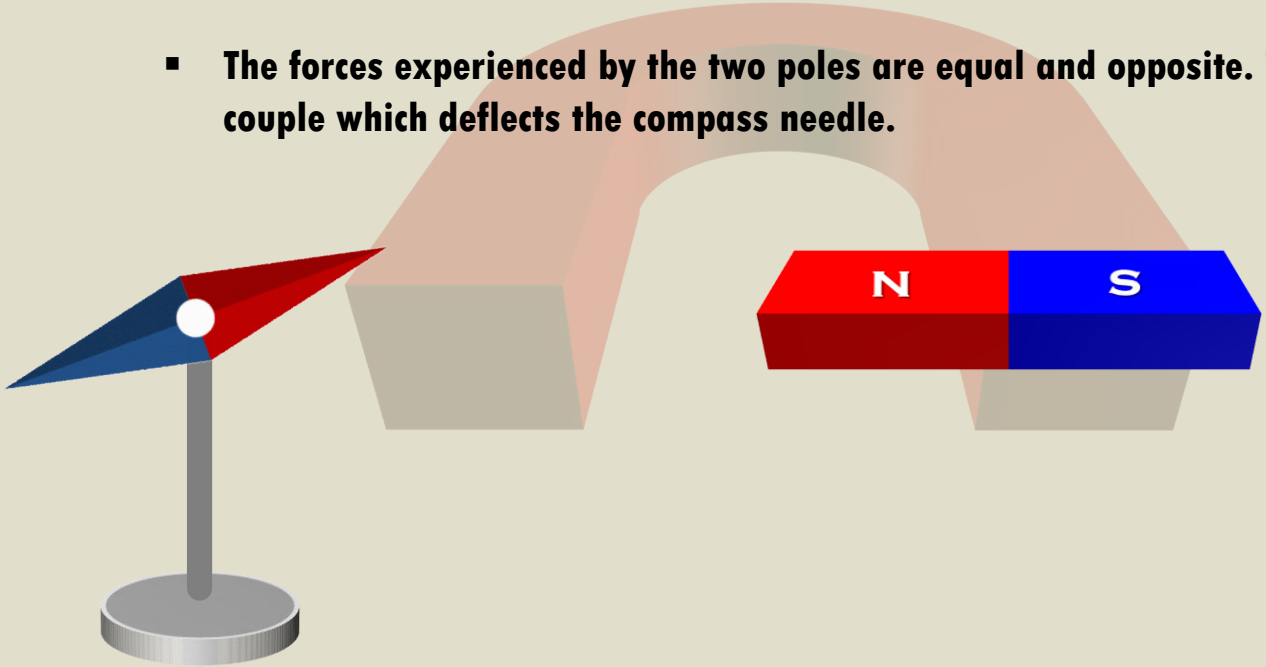
Magnetic field $\propto$ Current

$$\text{Magnetic field} \propto \frac{1}{\text{Distance}}$$

Q. Why does a compass needle get deflected when brought near a bar magnet?

Ans.

- The magnetic field of the magnet exerts force on both the poles of the compass needle.
- The forces experienced by the two poles are equal and opposite. These two forces form a couple which deflects the compass needle.

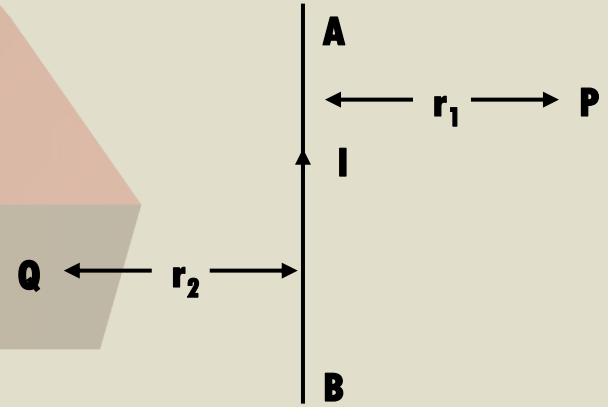


AB is a current carrying conductor in the plane of the paper as shown in figure.
(i) What are the directions of magnetic fields produced by it at points P and Q?
(ii) Given $r_1 > r_2$, where will the strength of the magnetic field be larger?

Ans.

- By applying Right-hand thumb rule, the direction of Magnetic field at P is into the plane of the paper and at the point Q, coming out from the plane of paper.

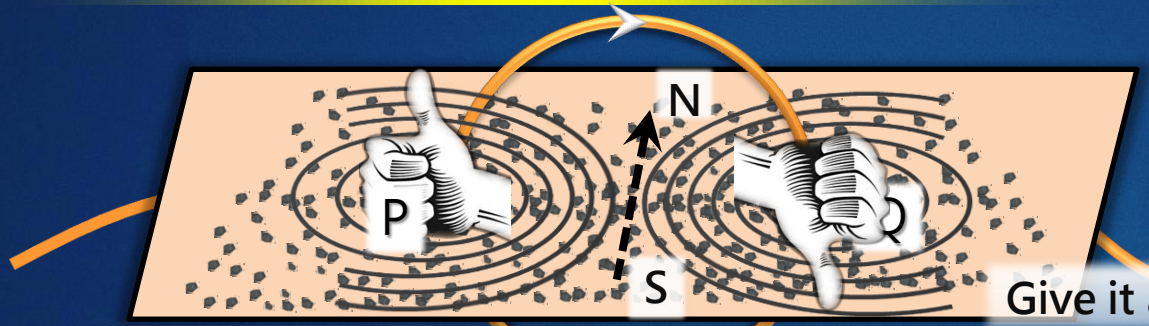
- The magnitude of magnetic field B is inversely proportional to distance r. Since r1 > r2, point Q is closer than point P. So the magnetic field is stronger at point Q and weaker at point P.

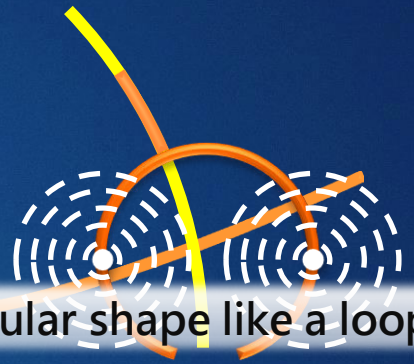


Thank You

LECTURE 2

Magnetic field produced by current through a circular loop of conducting wire

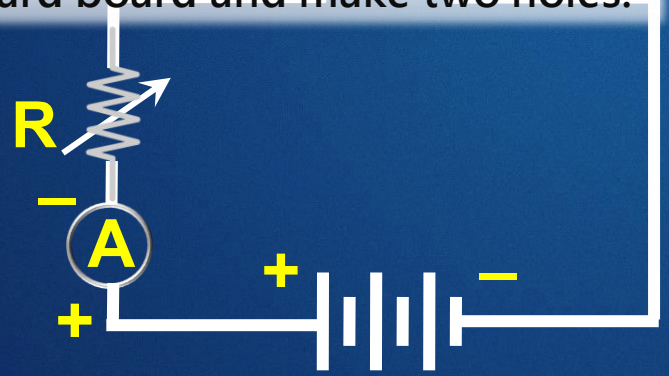




Give it a circular shape like a loop

Take a long conducting wire

Take a card board and make two holes.

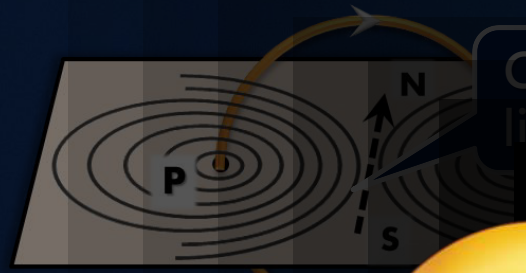


Conclusion

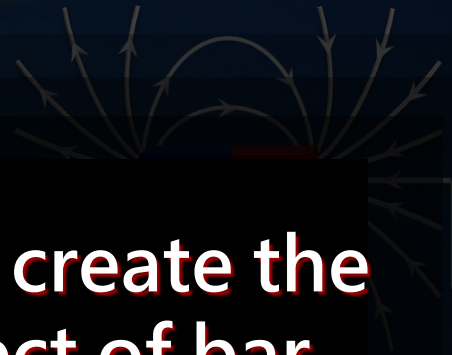
Magnetic field $\propto$ Current

Magnetic field $\propto \frac{1}{\text{Radius}}$

Magnetic field for different substances



Central field looks like a straight line.



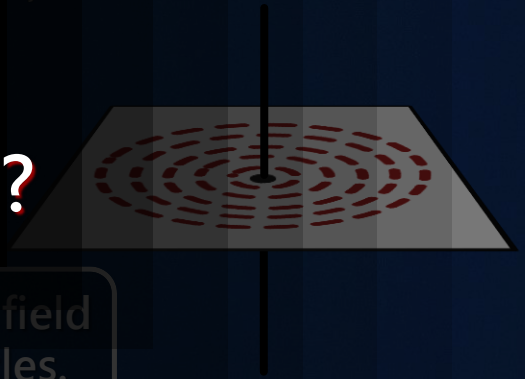
Magnet field looks like a butterfly

Magnetic field for a circular coil

Magnetic field is set of concentric circles at every point

Can I create the effect of bar magnet by passing current ?

Straight conductor field is a concentric circles.

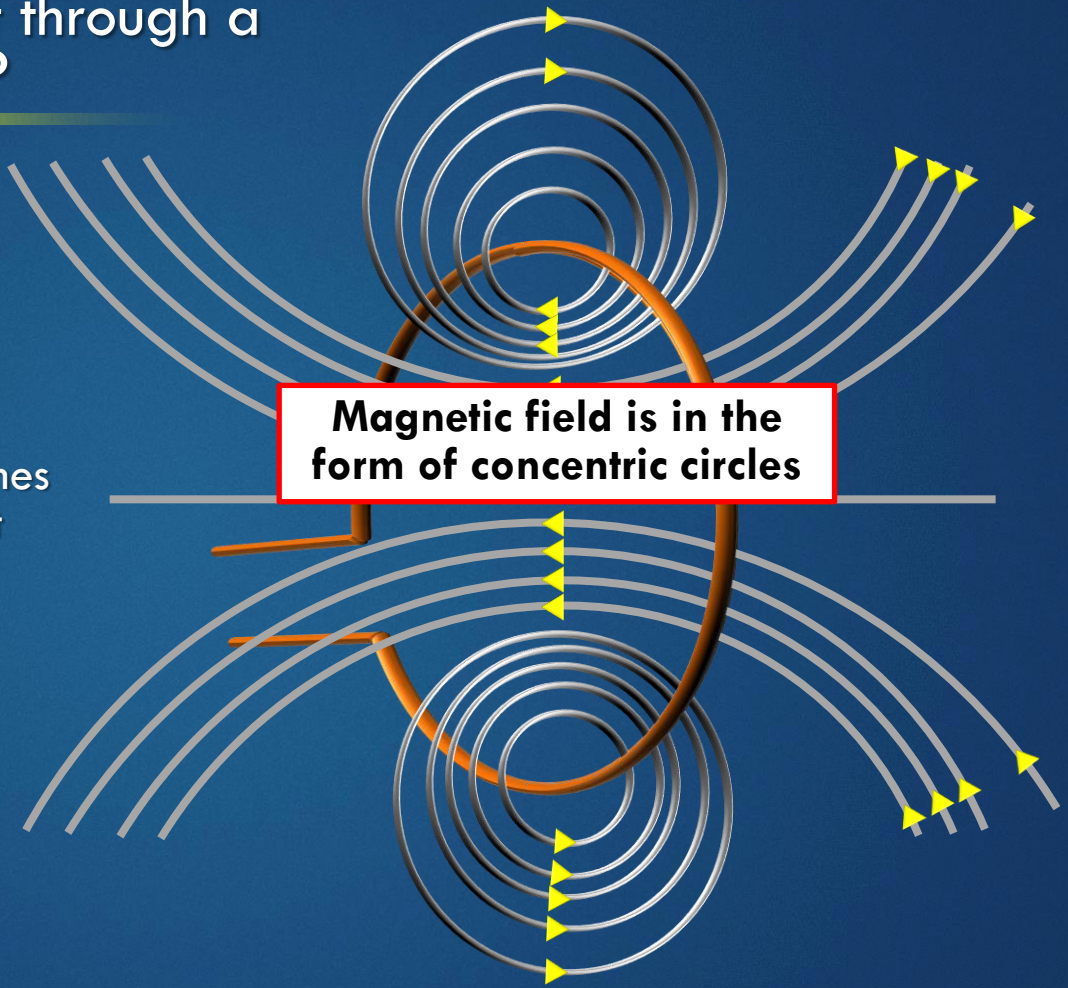


Magnetic field for a straight conductor

Magnetic field due to current through a CIRCULAR LOOP

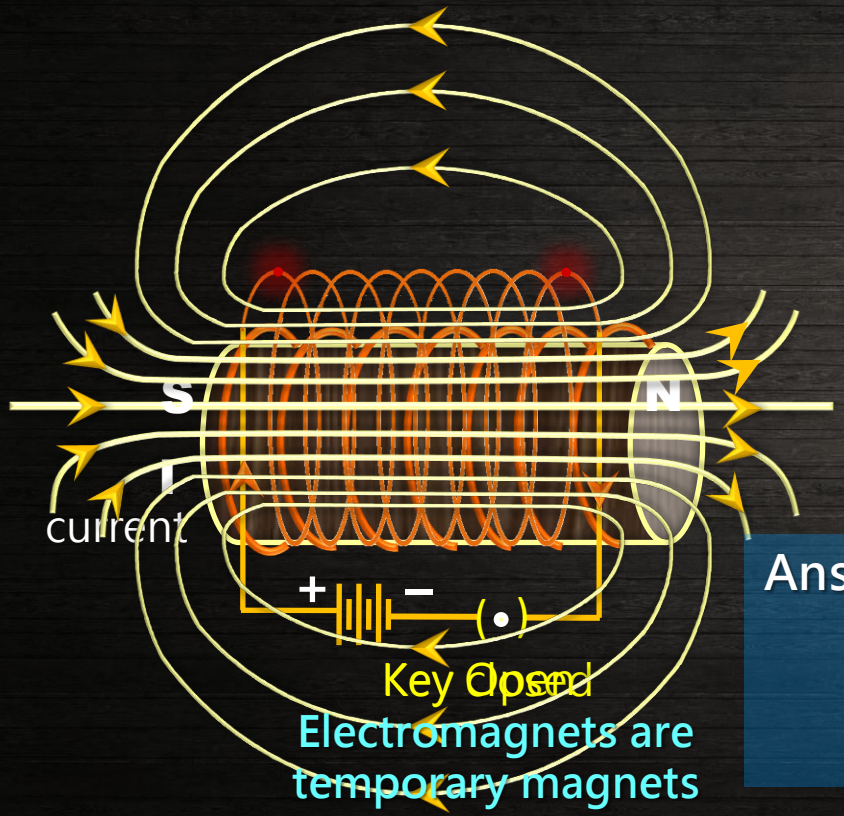
The right hand rule helps to find the direction of magnetic field

In the centre magnetic lines of force appear straight



SOLENOID

A coil of many circular turns of insulated copper wire wrapped in the shape of a cylinder.



Electromagnets are temporary magnets

Magnetic field ∝ Current

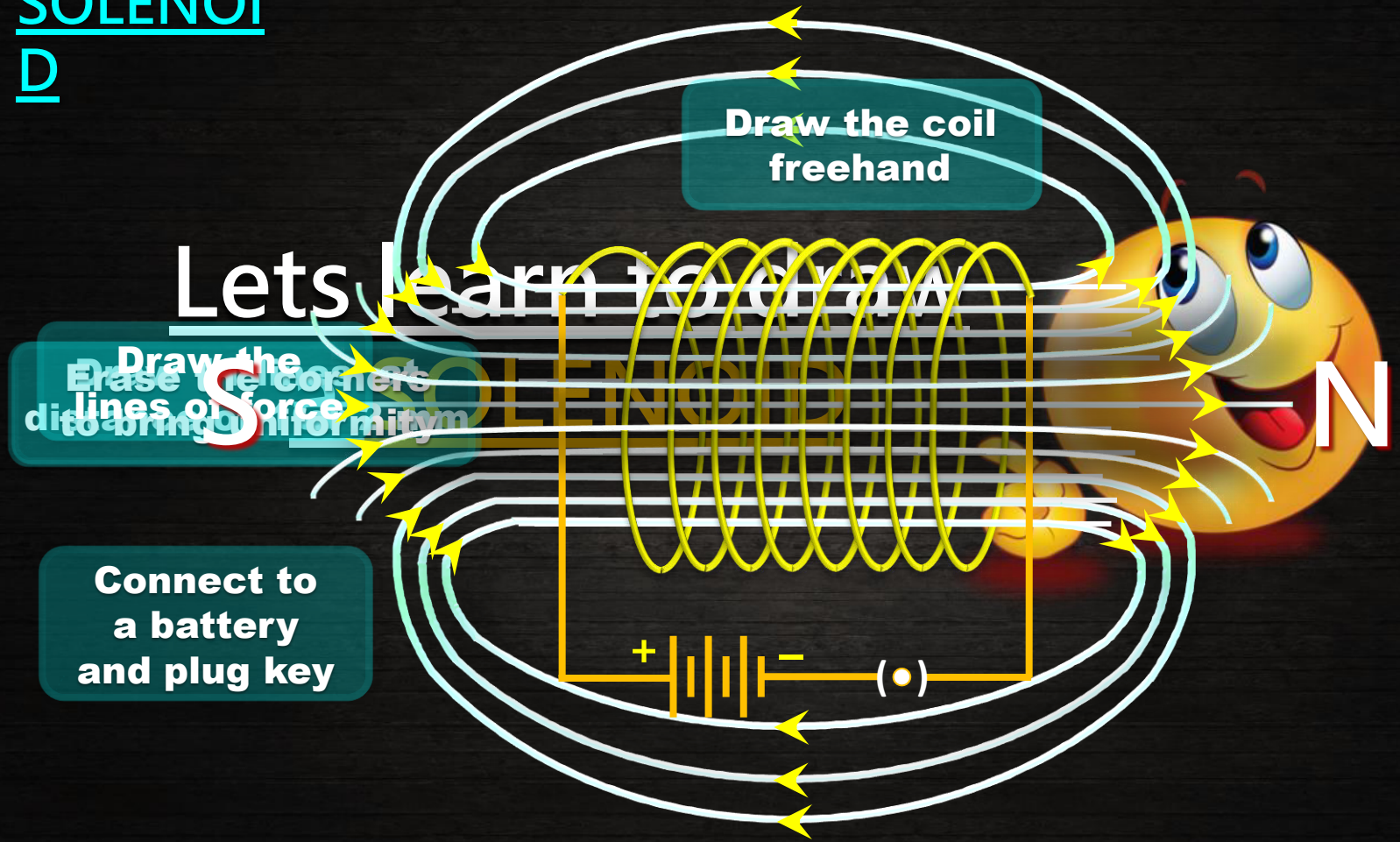
Magnetic field ∝ No of turns

$$\text{Magnetic field} \propto \frac{1}{\text{Radius of Coil}}$$

What does parallel lines of force inside the solenoid indicate ?

Ans: Intensity of the magnetic field within the solenoid is uniform everywhere, i.e. the magnetic field in a solenoid is uniform.

SOLENOID


Draw the coil freehand
Lets learn to draw
SOLENOID
Draw the lines of force
S
N
Connect to a battery and plug key
+
–

What is a solenoid? Compare the magnetic field produced by a solenoid with the magnetic field of a bar magnet.

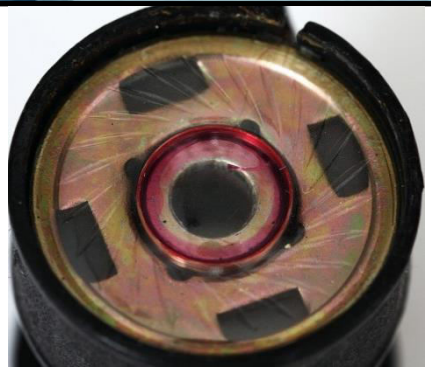
Ans :

1. When a copper wire with a resistive coating is wound in a chain of loops like a spring it is called solenoid.
2. When an electric current is passed through a solenoid magnetic field is produced in it.
3. The magnetic lines of force are similar to that of the lines of a bar magnet.
4. Solenoid has all properties of the field produced by a bar magnet.
5. One end of the coil acts as a south pole, while the other end as north pole.

LIFTING SCRAP IRON

SPEAKER

Nipermag, Alnico



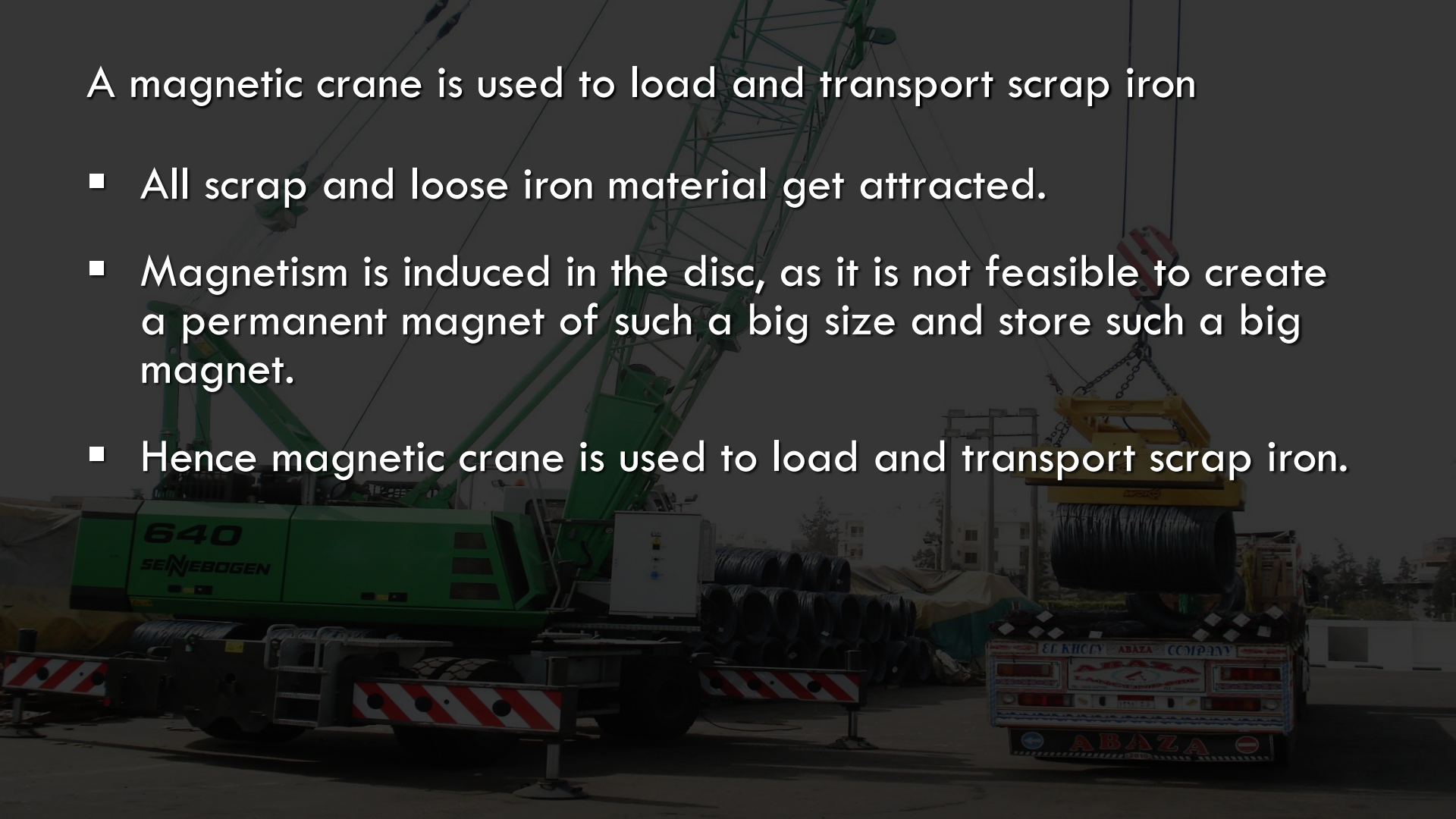
Microphones

Loudspeakers

Electric clock

A magnetic crane is used to load and transport scrap iron

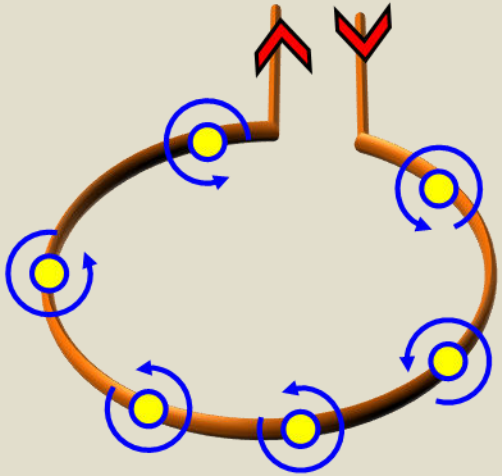
- All scrap and loose iron material get attracted.
- Magnetism is induced in the disc, as it is not feasible to create a permanent magnet of such a big size and store such a big magnet.
- Hence magnetic crane is used to load and transport scrap iron.



Q. **Consider a circular loop of wire lying in the plane of the table. Let the current pass through the loop clockwise. Apply the right-hand rule to find out the direction of the magnetic field inside and outside the loop.**

Ans.

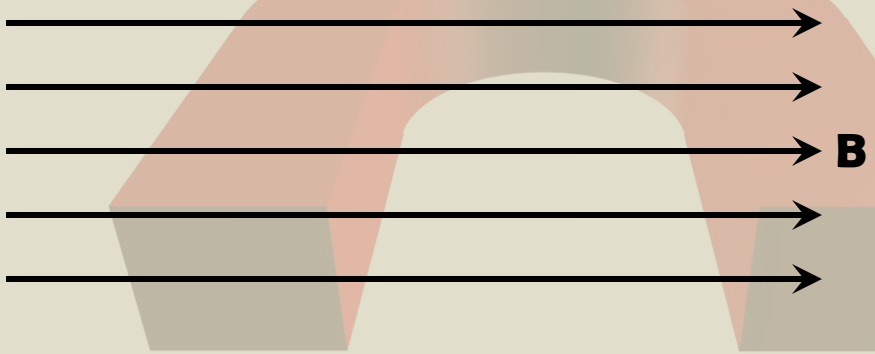
- Each section of wire produces its concentric set of lines of force.
- By applying right hand thumb rule, we find that all the sections produce magnetic field directed downward at all points inside the loop while at the outside points, the field is directed upwards.
- Hence, the magnetic field acts normally into the plane of paper at the points inside the loop and normally out of the plane of paper at points outside the loop



Q. **The magnetic field in a given region is uniform. Draw a diagram to represent it.**

Ans.

- The uniform magnetic field B can be represented by equidistant parallel lines of force, as shown in Fig.



Choose the correct option :

The magnetic field inside a long straight solenoid-carrying current

(a) is zero;

(b) decreases as we move towards its end;

(c) increases as we move towards its end;

(d) is the same at all points.

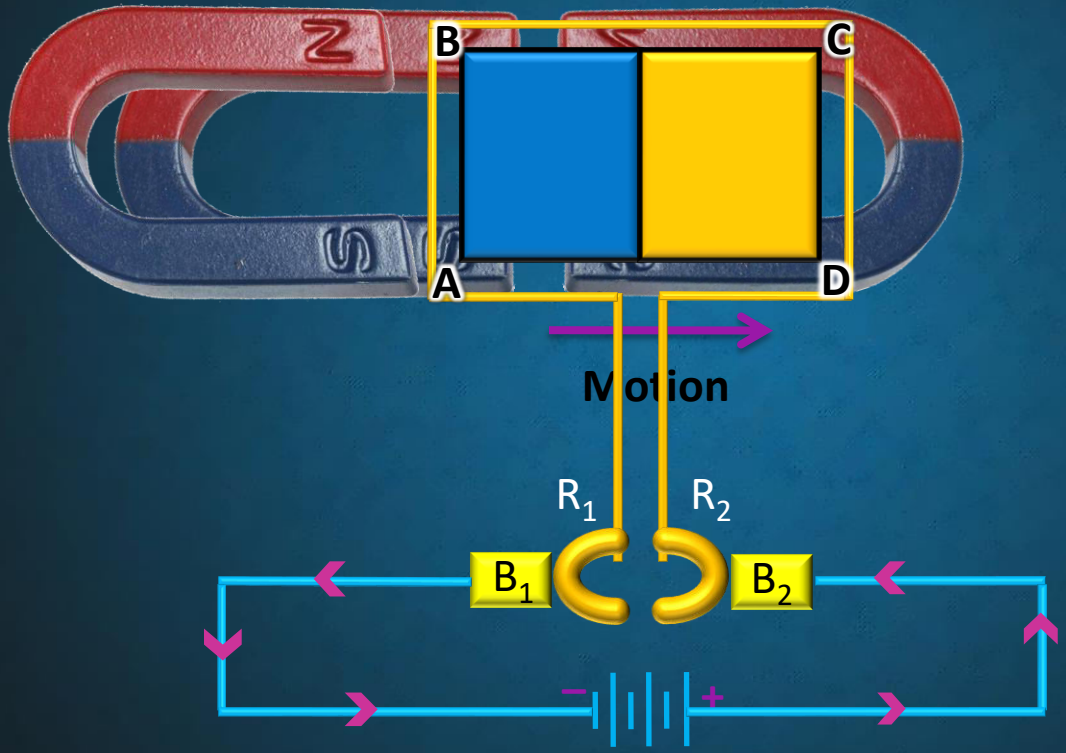
Q.

Ans. d. It is the same at all inside points.

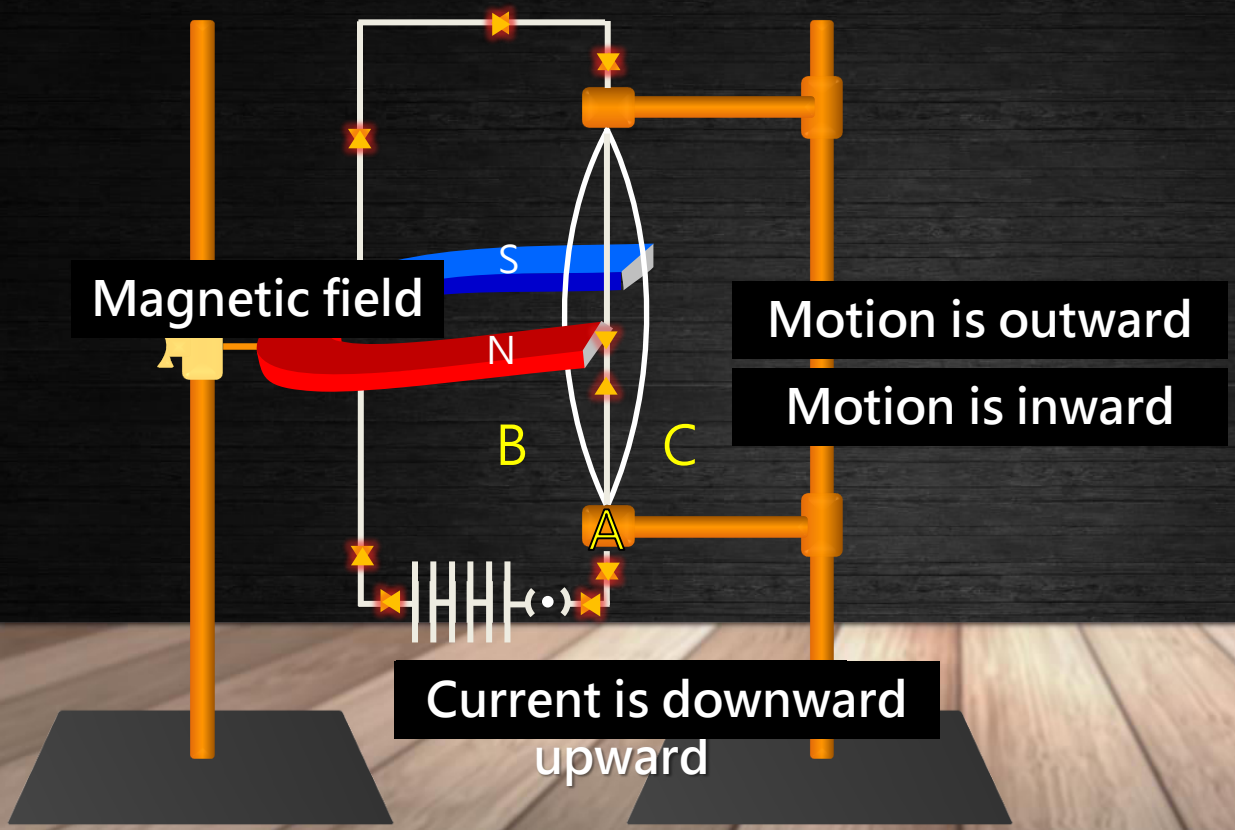
Thank You

LECTURE 3

Force acting on a current carrying conductor placed in magnetic field



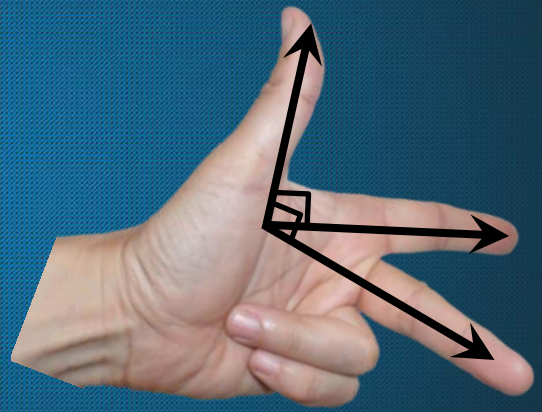
Experiment to observe force experience by a current carrying conductor



Fleming's Left Hand Rule

Stretch the thumb, the forefinger and the middle finger of the left hand in such a way that they are perpendicular to each other.

If,
forefinger is in the direction of the magnetic field,
middle finger is in the direction of the current
then the thumb shows the direction of the force on the conductor.

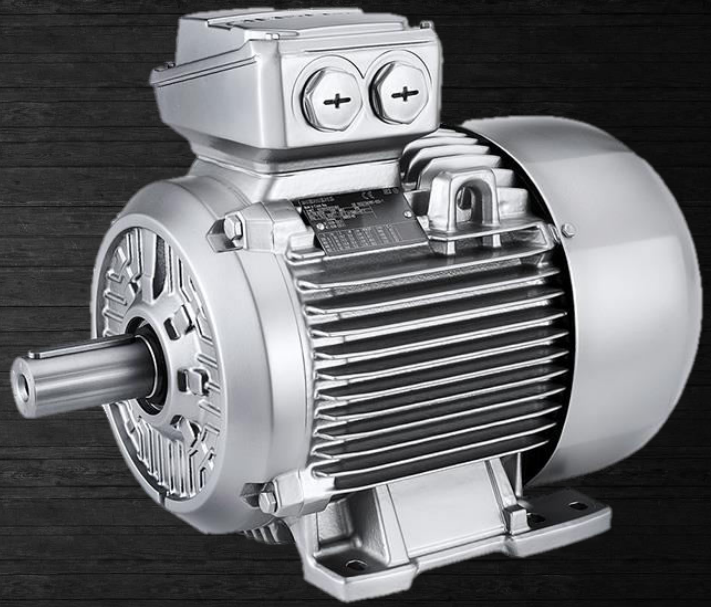


Electric Motor

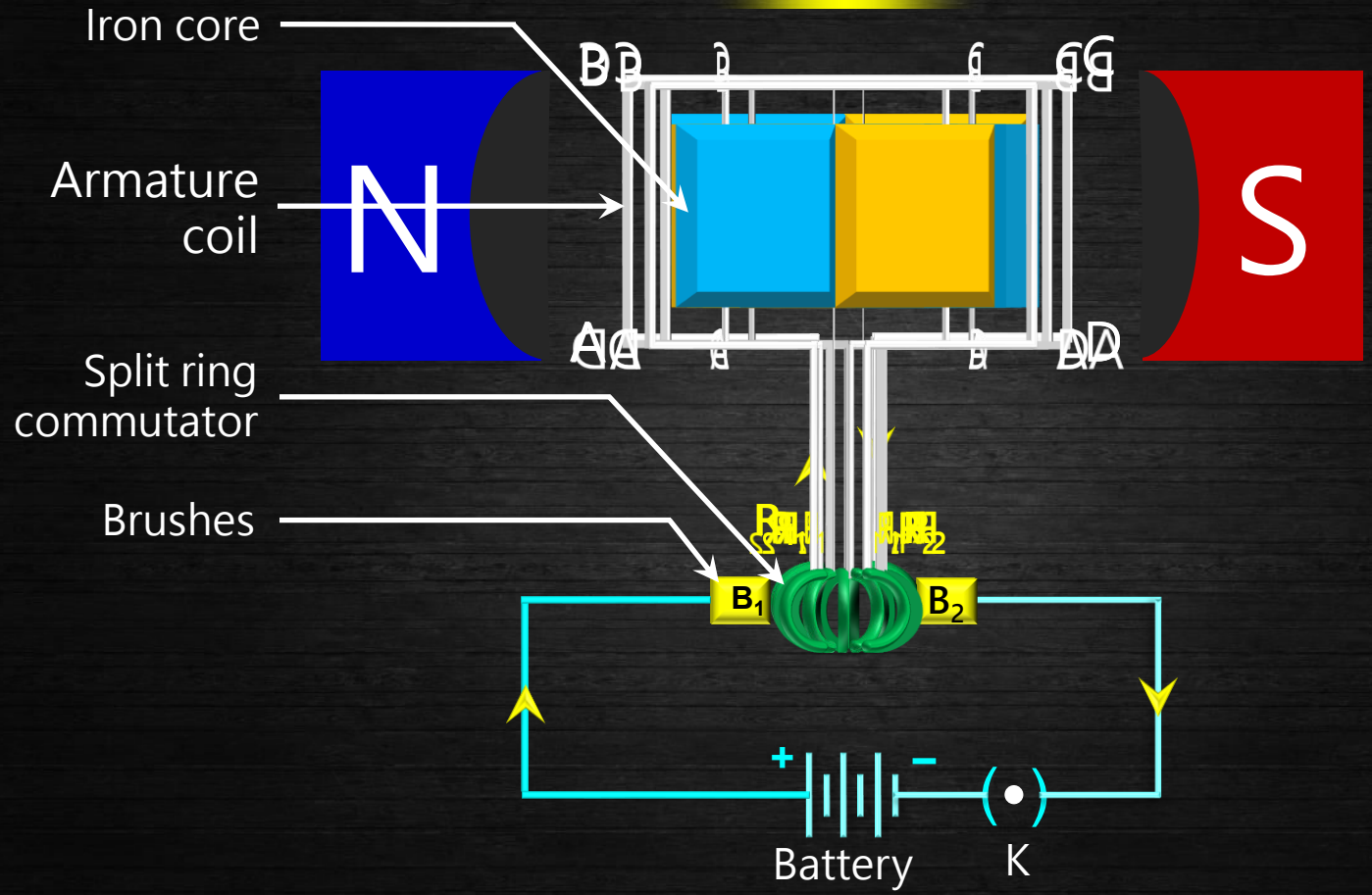
A device changing electrical energy into mechanical energy is known as ELECTRIC MOTOR.

WORKING PRINCIPLE :

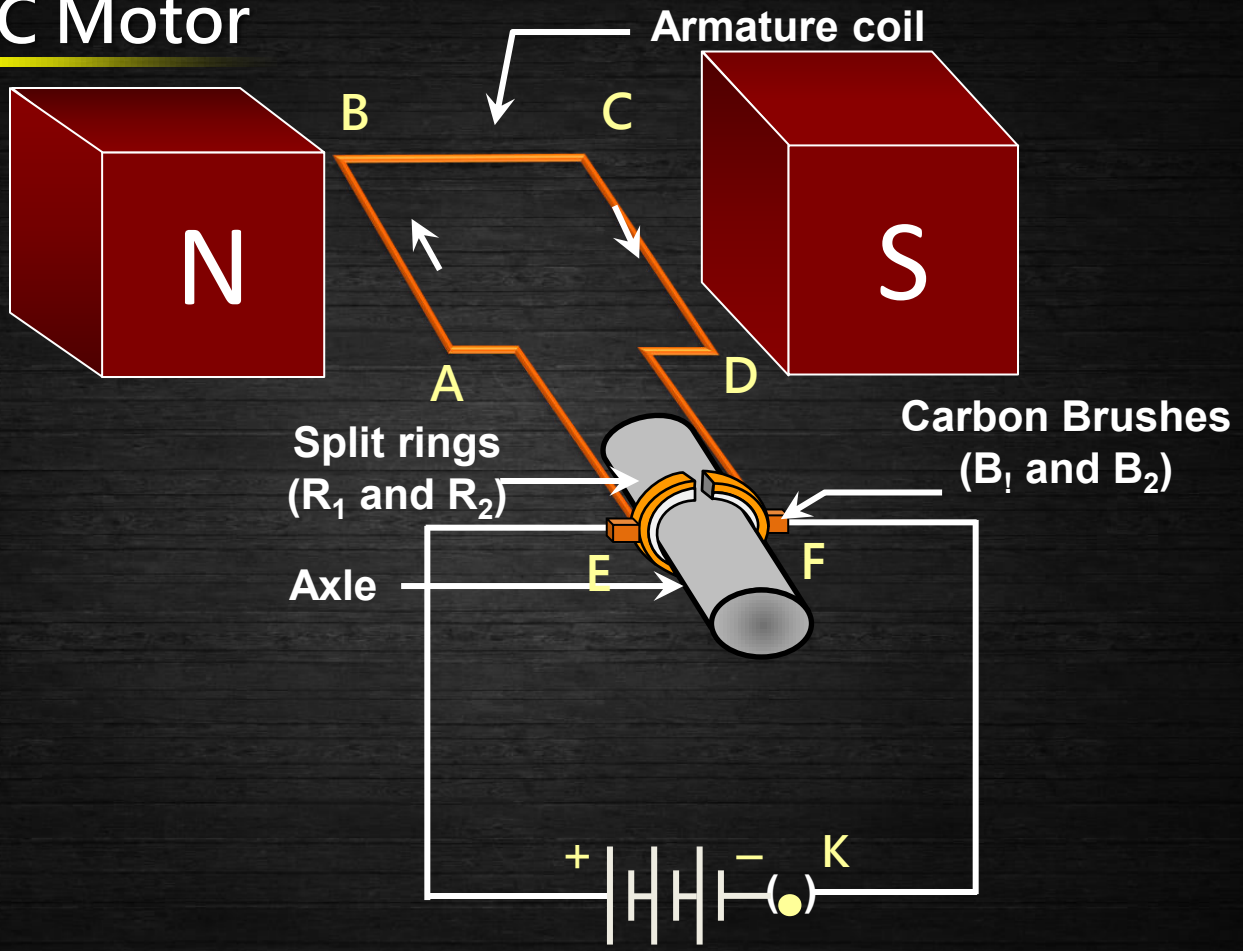
Force is exerted on a current carrying conductor placed in a magnetic field

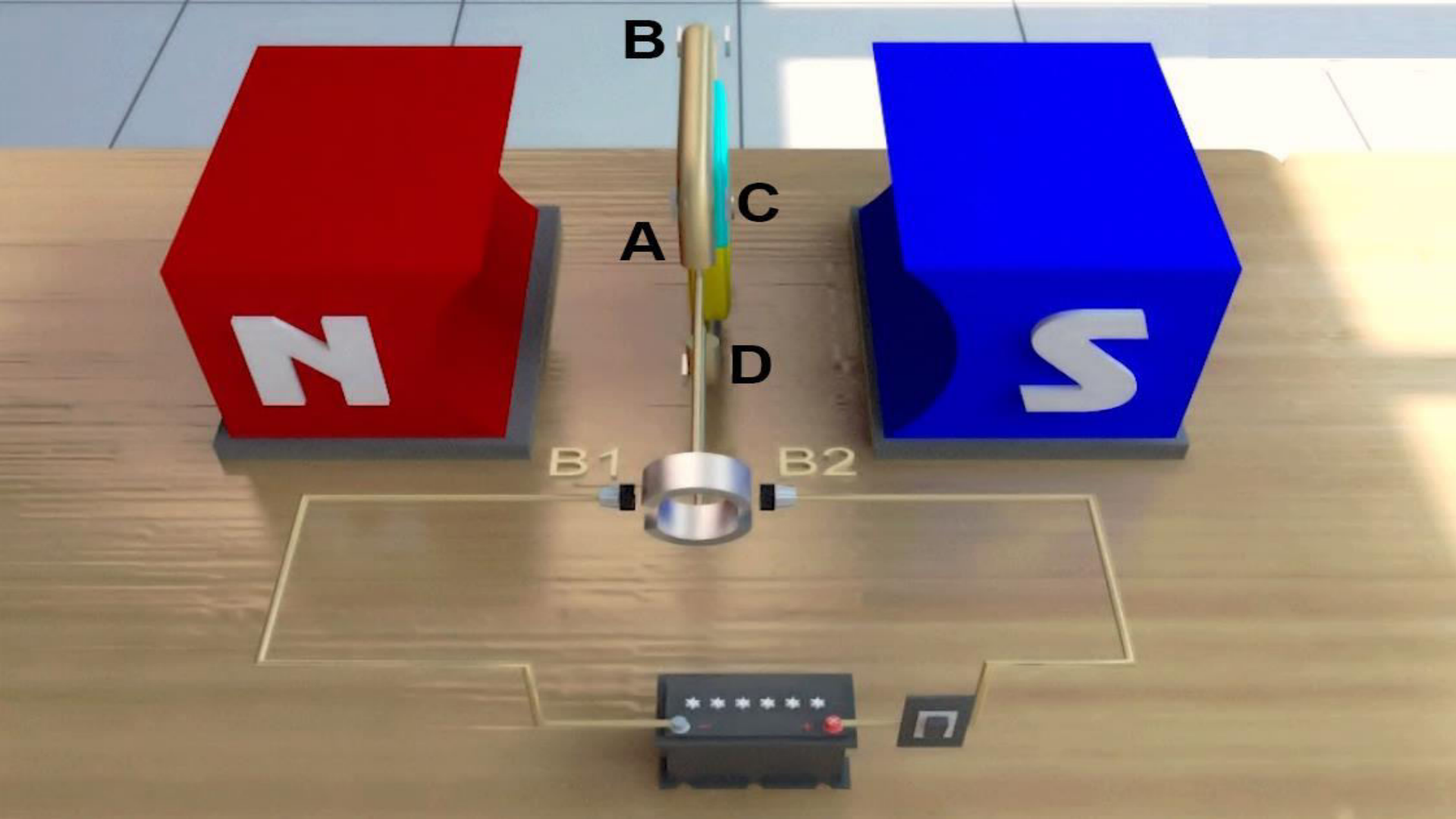


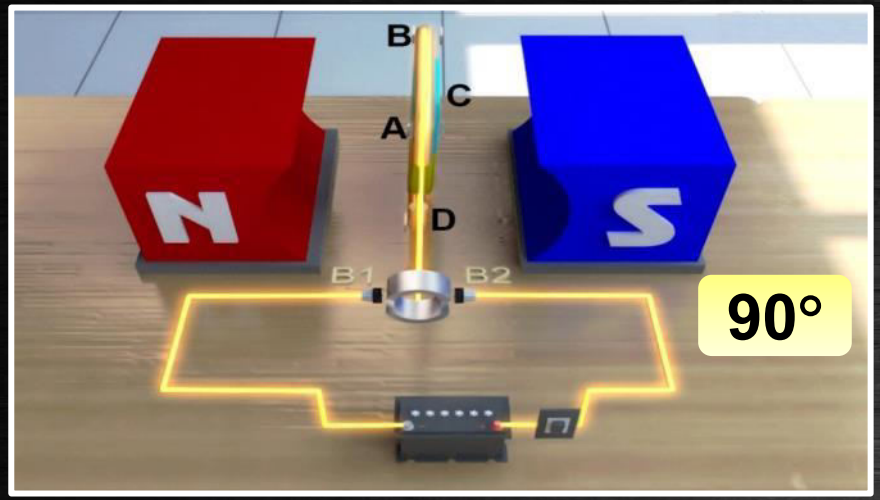
Electric/DC Motor

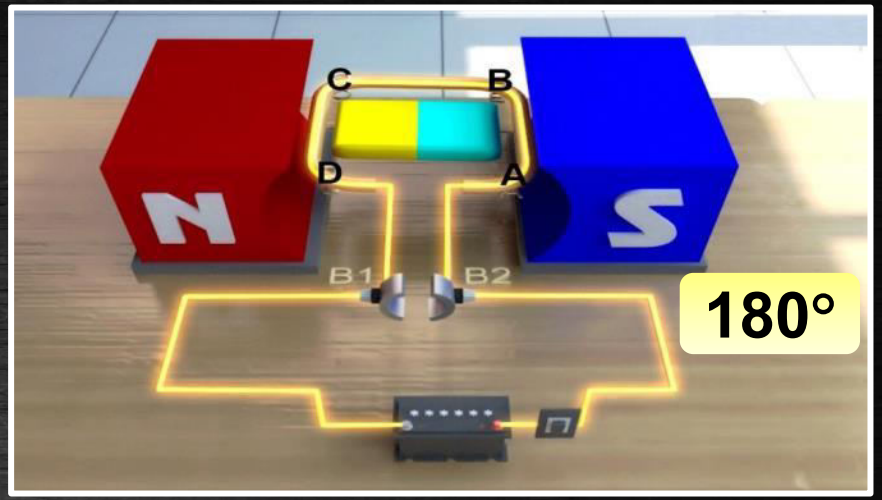


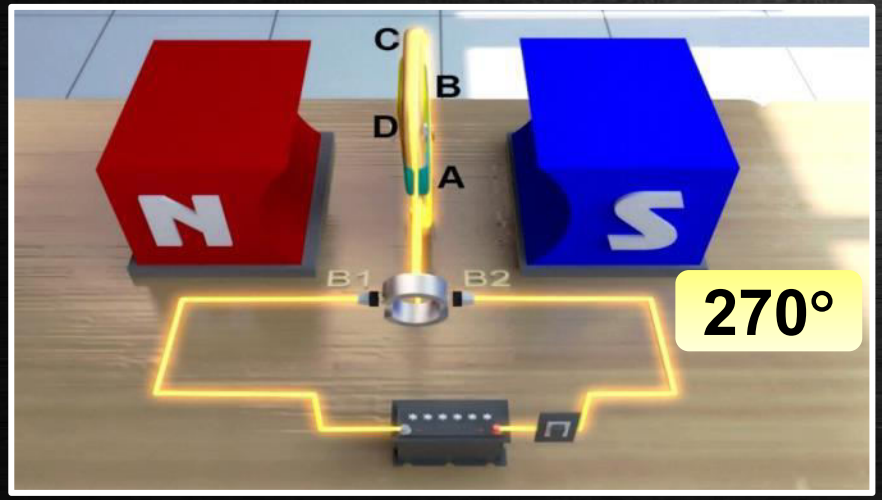
Drawing of DC Motor

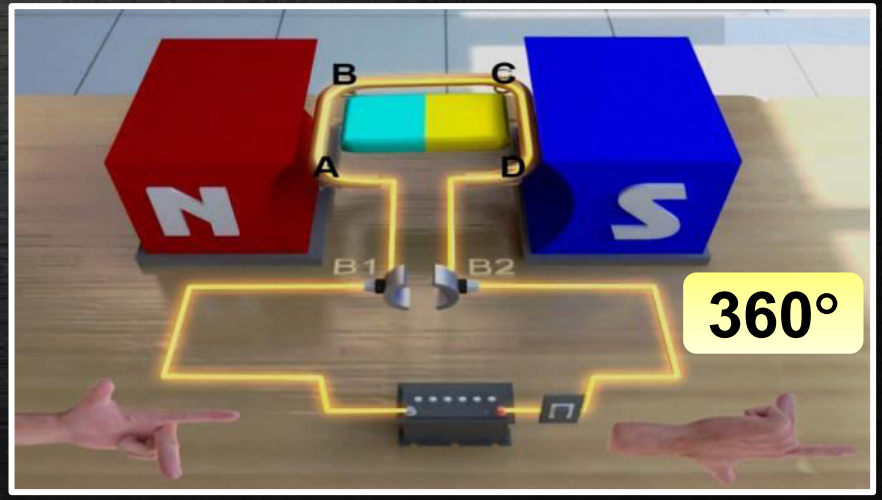


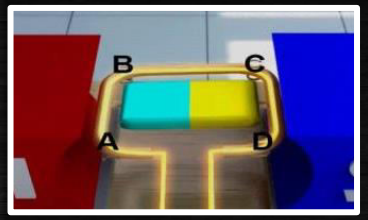

B
C
A
D
N
S
B1
B2


B
C
A
D
N
S
B1
B2
90°

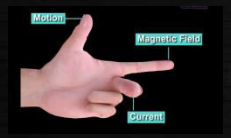

C
B
D
A
N
S
B1
B2
180°


C
B
D
A
N
S
B1
B2
270°

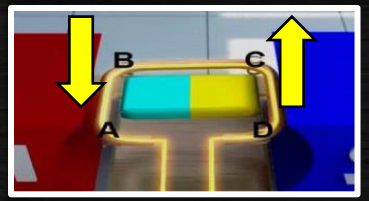

B
C
A
D
N
S
B1
B2
360°



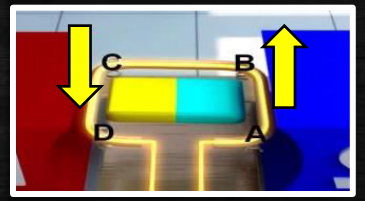
1. In the first half cycle, current flows in the armature coil along A-B-C-D
2. Arms AB and CD experience a force



3. Direction of force can be found using Flemings left hand rule



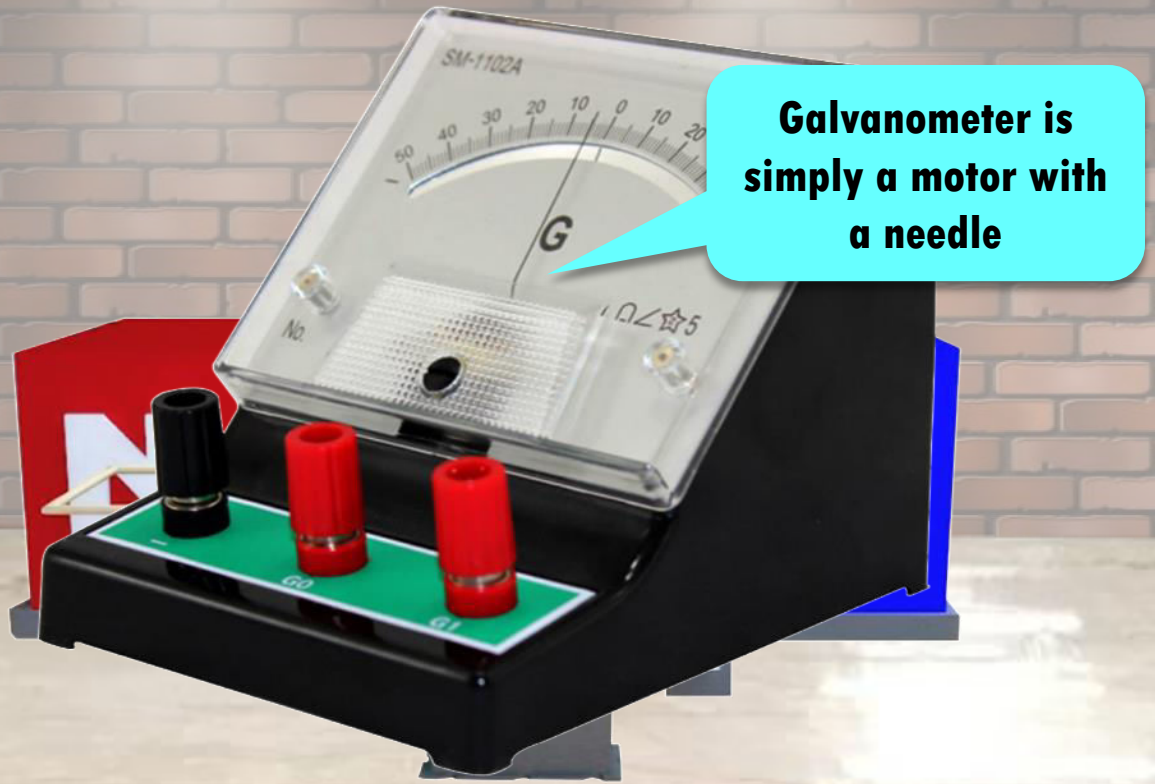
4. Arm AB moves downward and CD moves upward
5. The armature coil rotates in the anticlockwise direction.



6. In the next half cycle, arms AB and CD exchange their positions and current flows in the armature coil along D-C-B-A
7. Arm CD moves downward and AB moves upward
8. The armature coil continues to rotate in the anticlockwise direction.

9. The split ring commutator reverses the direction of current every half cycle.

Galvanometer



Galvanometer is simply a motor with a needle

ANSWER

Q. When will the induced current in the electrical conductor (coil) be maximum?

Ans : It will be maximum when the direction of motion of the electric conductor is perpendicular to the magnetic field.

Q. When will the induced current in the electrical conductor (coil) be minimum?

Ans : It will be minimum when the direction of motion of the electric conductor is parallel to the magnetic field.

Q. A current carrying straight conductor is placed in east-west direction. What will the direction of the force experienced by this conductor due to earth's magnetic field? How will this force get affected on:

i. reversing the direction of flow of current?
ii. doubling the magnitude of current?

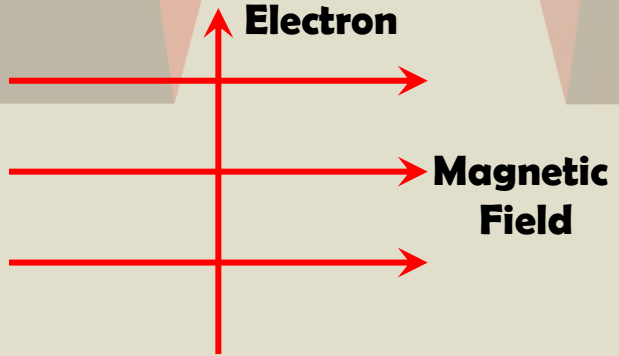
Ans. The direction of earth's magnetic field is from geographical south to geographical north. According to Fleming's left hand rule, the current carrying straight conductor placed in east-west direction will be deflected downwards.

i. On reversing the direction, the conductor is deflected in the upward direction.
ii. If the magnitude of current is doubled, it will result in doubling the magnitude of force.

Q. **An electron enters a uniform magnetic field at right angles to it as shown in Fig. In which direction will this electron move? State the principle applied by you in finding the direction of motion of the electron.**

Ans. **The electron will move normally outward.**

Fleming's left hand rule: **Stretch the forefinger, the central finger and the thumb of the left hand mutually perpendicular to each other. If the forefinger points in the direction of the magnetic field, the central finger in the direction of current, then the thumb points in the direction of force on the conductor.**



Q. Which of the following property of a proton can change while it moves freely in a magnetic field? (There may be more than one correct answer.)

(a) mass (b) speed

(c) velocity (d) momentum

Ans.

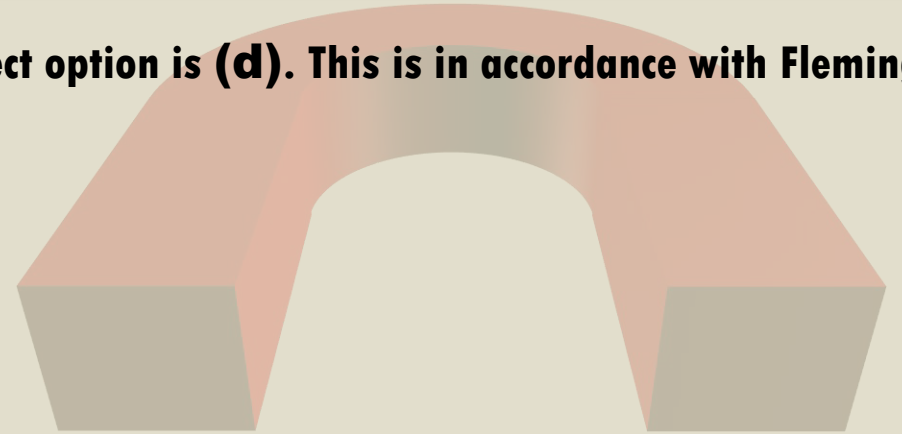
The correct option are **(c)** and **(d).** The magnetic force acts perpendicular to the direction of motion of the proton. It does not change its mass and speed but changes its direction of motion. So both velocity and momentum get changed.

Q. A positively-charged particle (alpha-particle) projected towards west is deflected towards north by a magnetic field. The direction of magnetic field is

(a) towards south (b) towards east

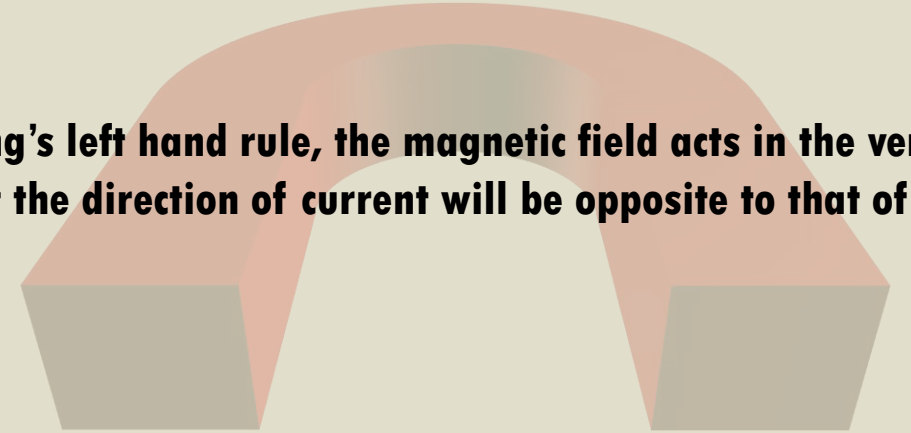
(c) downward (d) upward

Ans. The correct option is **(d)**. This is in accordance with Fleming's left hand rule.



Q. Imagine that you are sitting in a chamber with your back to one wall. An electron beam, moving horizontally from back wall towards the front wall, is deflected by a strong magnetic field to your right side. What is the direction of magnetic field?

Ans.



According to Fleming's left hand rule, the magnetic field acts in the vertically downward direction. Note that the direction of current will be opposite to that of the electron beam.

Thank You

LECTURE 4

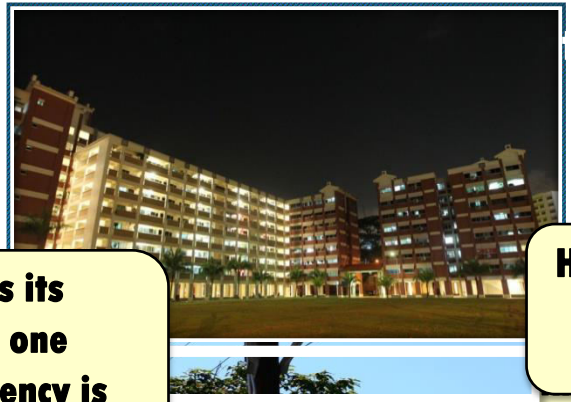
Electric Current

Direct Current (D.C.)

Battery gives DC current

D.C. current changes its direction 0 times in one second hence its frequency is 0 Hz.

for household purpose.



ernating Current (A.C.)

Households mostly get AC current

transformers it is distributed to households.

away distances

household purpose.

Write the differences between

Alternating Current and Direct Current

Direct Current (D.C.)

- The magnitude and direction of the current is constant.
- The frequency of direct current is zero.
- This current cannot be used on large scale for household purpose.

Alternating Current (A.C.)

- The magnitude and direction of the current reverses periodically.
- Frequency of AC in India is about 50hz.
- This current can be used on a large scale for household purpose.

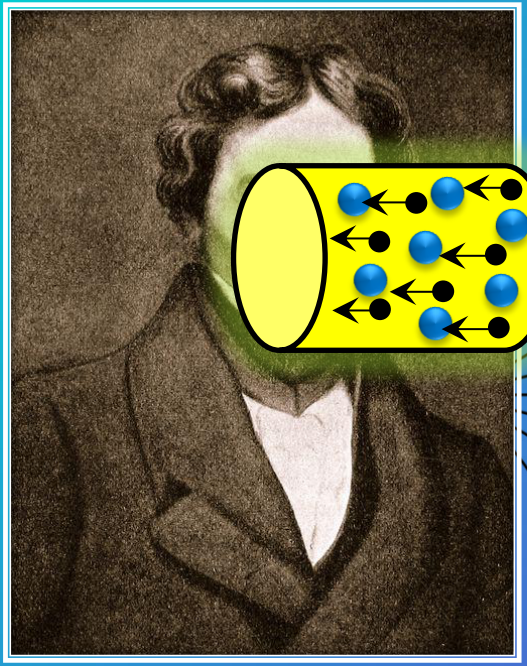
Q. **Why is alternating current preferred over direct current? List any three reasons.**

Ans.

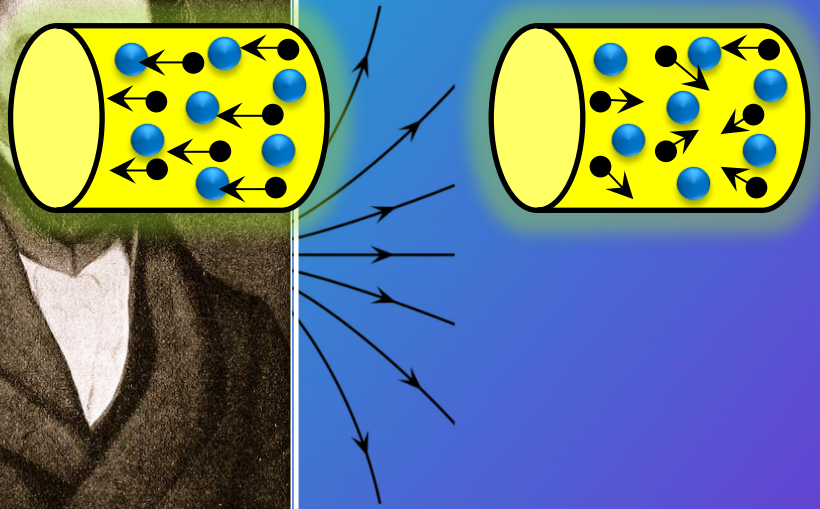
Advantages of a.c. over d.c.

1. **The generation of a.c. is more economical than d.c.**
2. **The alternating voltage can be easily steeped up or stepped down by using a transformer.**
3. **The alternating currents can be transmitted to distant places without any significant line loss.**

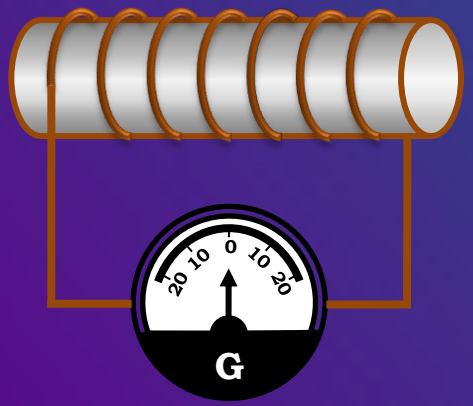
ELECTROMAGNETIC INDUCTION



MICHAEL FARADAY
(1931)



ELECTROMAGNETIC INDUCTION



The process by which a changing magnetic field in a conductor induces a current in another conductor, is called **Electromagnetic Induction.**

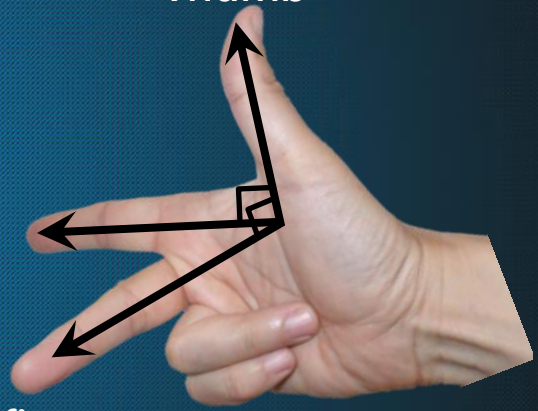
- **Hence, we conclude that**
  - **Motion of the magnet with respect to the coil produces an induced potential difference which sets up an induced electric current in the circuit.**

- **The direction of induced current depends on,**
  - **(i) Direction of motion of conductor.**
  - **(ii) Direction of magnetic field.**

Fleming's Right Hand Rule

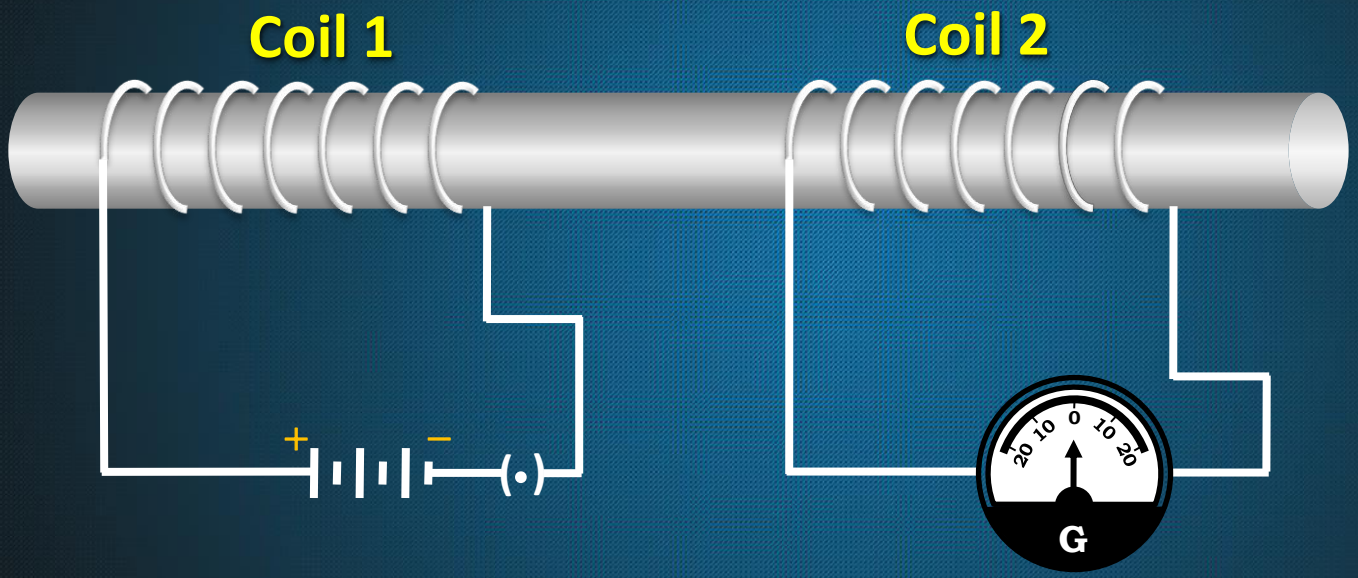
Stretch the thumb, the forefinger and the middle finger of the right hand in such a way that they are perpendicular to each other.

If
thumb is in the direction of motion of the conductor,
forefinger is in the direction of the magnetic field,
Then the middle finger shows the direction of the induced current.



Activity To Observe

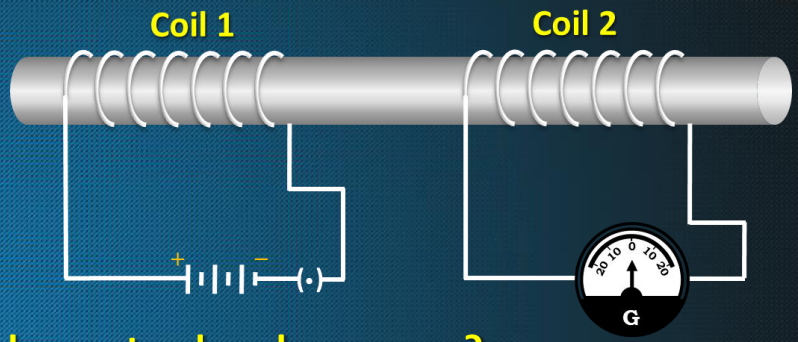
Induced Current



Activity To Observe

Induced Current

(i) What do you observe when you switch on the current in coil 1, i.e. when you connect coil 1 to the battery?



Ans: when coil 1 is connected to the battery, we observe deflection in the galvanometer connected to coil 2.

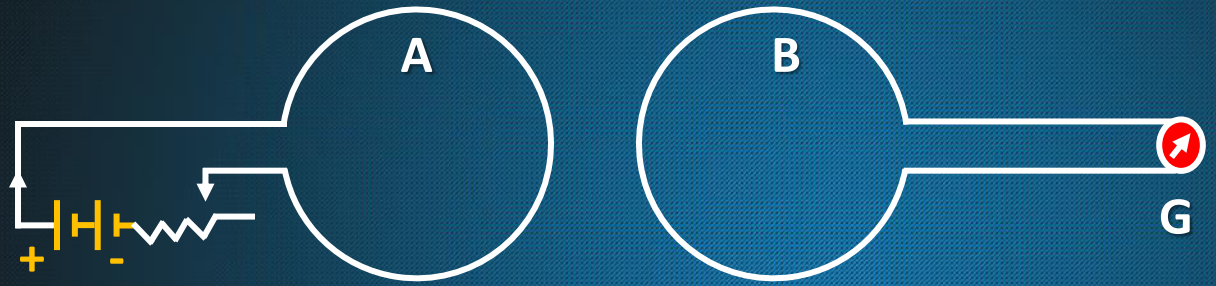
(ii) What do you observe when current in coil 1 reaches a steady value or zero?

Ans: When the current in coil 1 reaches a steady value or becomes zero, there is no deflection in the galvanometer.

(iii) Why is current induced in coil 2 when we connect coil 1 to a battery?

Ans: When we connect the coil to the battery, current starts flowing, hence there is a change is the magnetic field. This change in magnetic field induces a current in coil 2 the process by which changing magnetic field induces a current in another conductor is called electromagnetic induction.

Observe the figure. If the current in the coil A is changed, will some current be induced in the coil B? Explain.



- If the current in coil A is changed, then some current will be induced in coil B.
- As the current in coil A changes, the magnetic field related to it also change.
- Due to the changing magnetic field. Current is induced in coil B.

Q.

Explain different ways to induce current in a coil.

Or

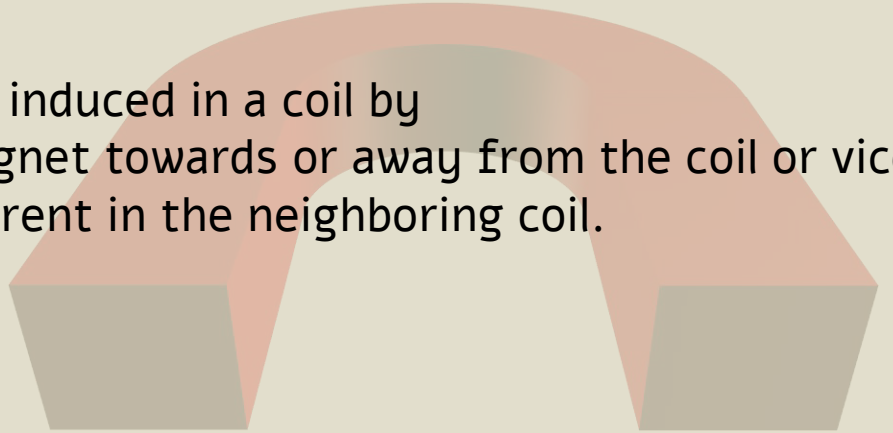
List two different ways of induced current in a coil.

Ans.

A current can be induced in a coil by

i. moving a magnet towards or away from the coil or vice versa, and

ii. Changing current in the neighboring coil.



Thank You

LECTURE 5

AC GENERATOR

A device changing Mechanical energy into Electrical energy.

WORKING PRINCIPLE :

Works on the principle of ELECTROMAGNETIC INDUCTION.

AC GENERATOR

The main components of AC generator are

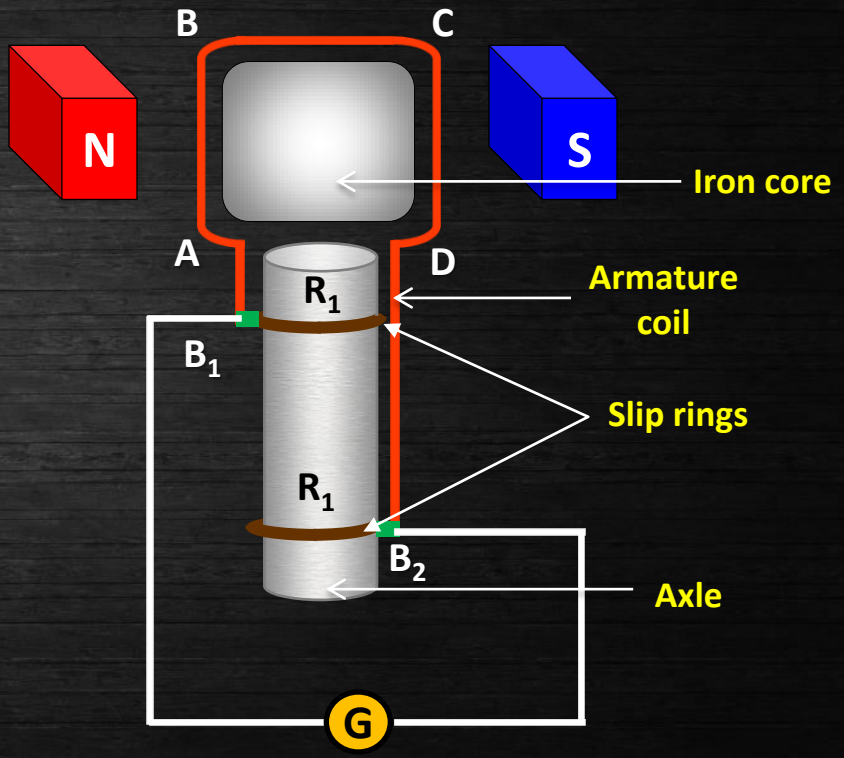
Armature coil **Strong magnet**

Slip rings **Brushes**

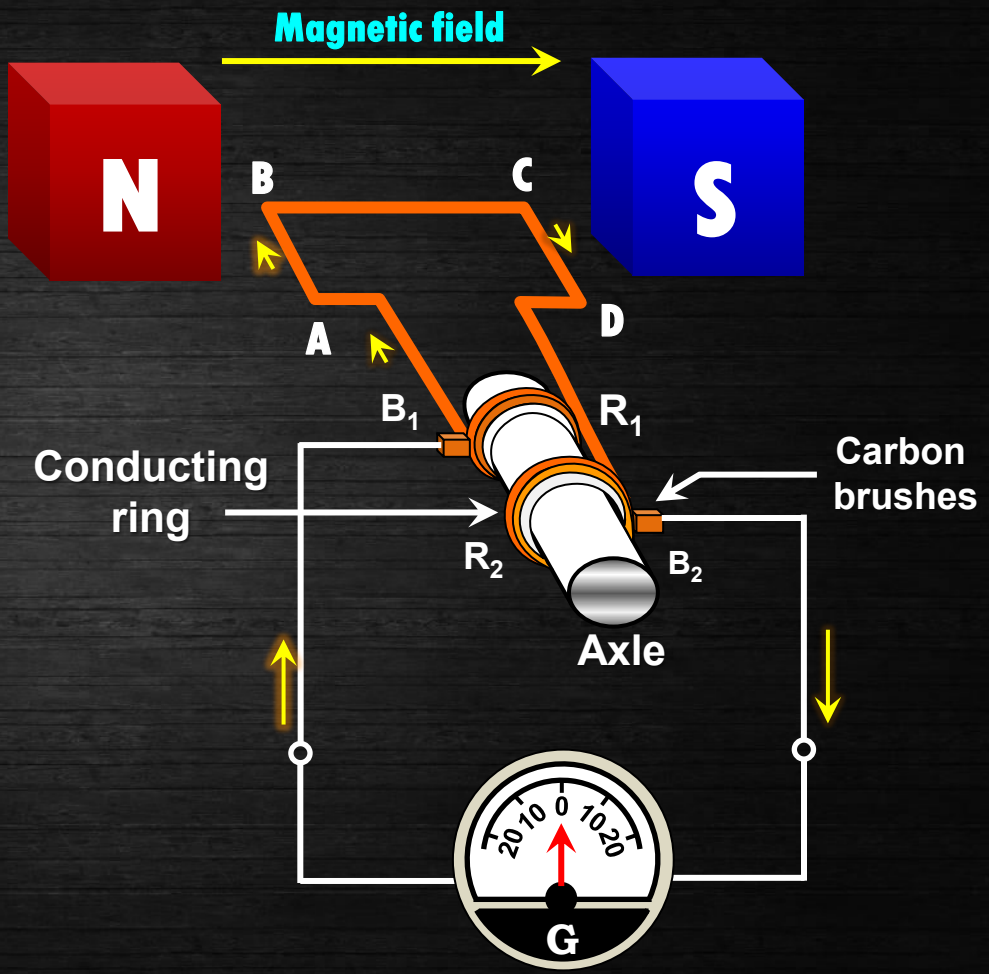
Armature, strong magnets and brushes are the same as used for electric motors.

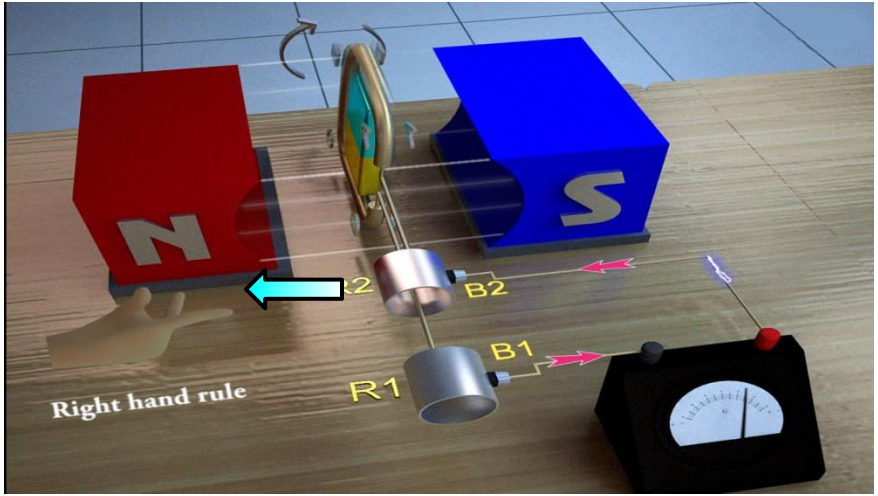
Slip rings : The two ends of the armature coil are connected to two brass slit rings R_1 and R_2. These rings rotate along with the armature coil

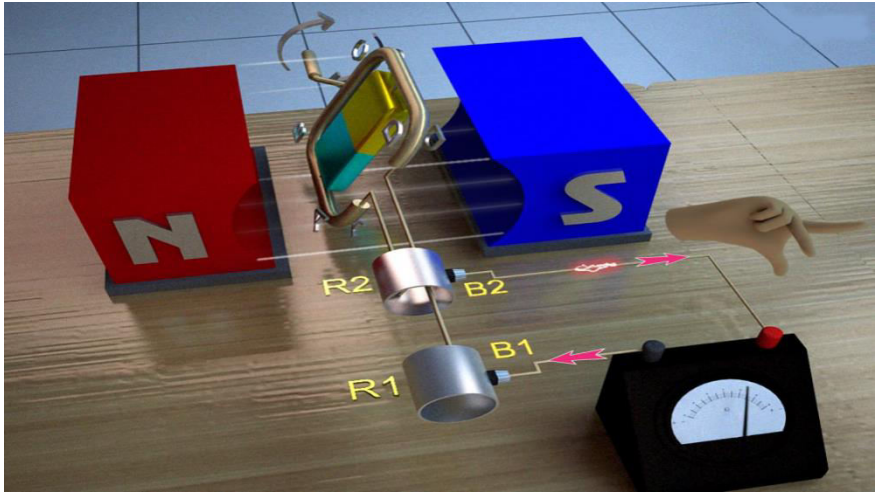
- CONSTRUCTION

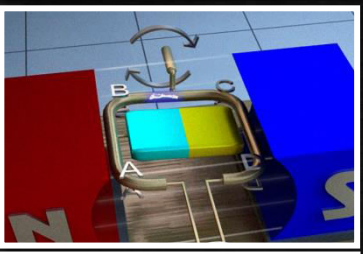


Drawing of AC generator

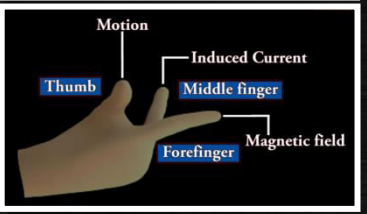



N
S
B2
B1
R1
Right hand rule

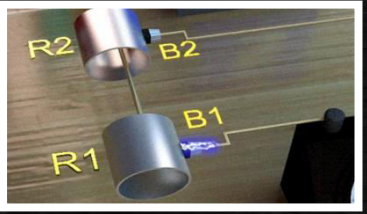

N
S
R2
B2
B1
R1



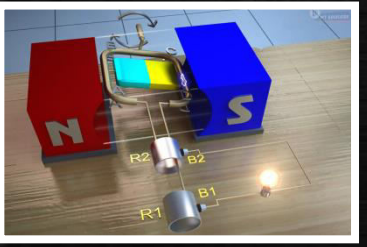
1. The armature coil is rotated in a magnetic field
2. It cuts the magnetic lines of force
3. A current is induced in the armature coil



4. The direction of induced current can be found using Flemings right hand rule



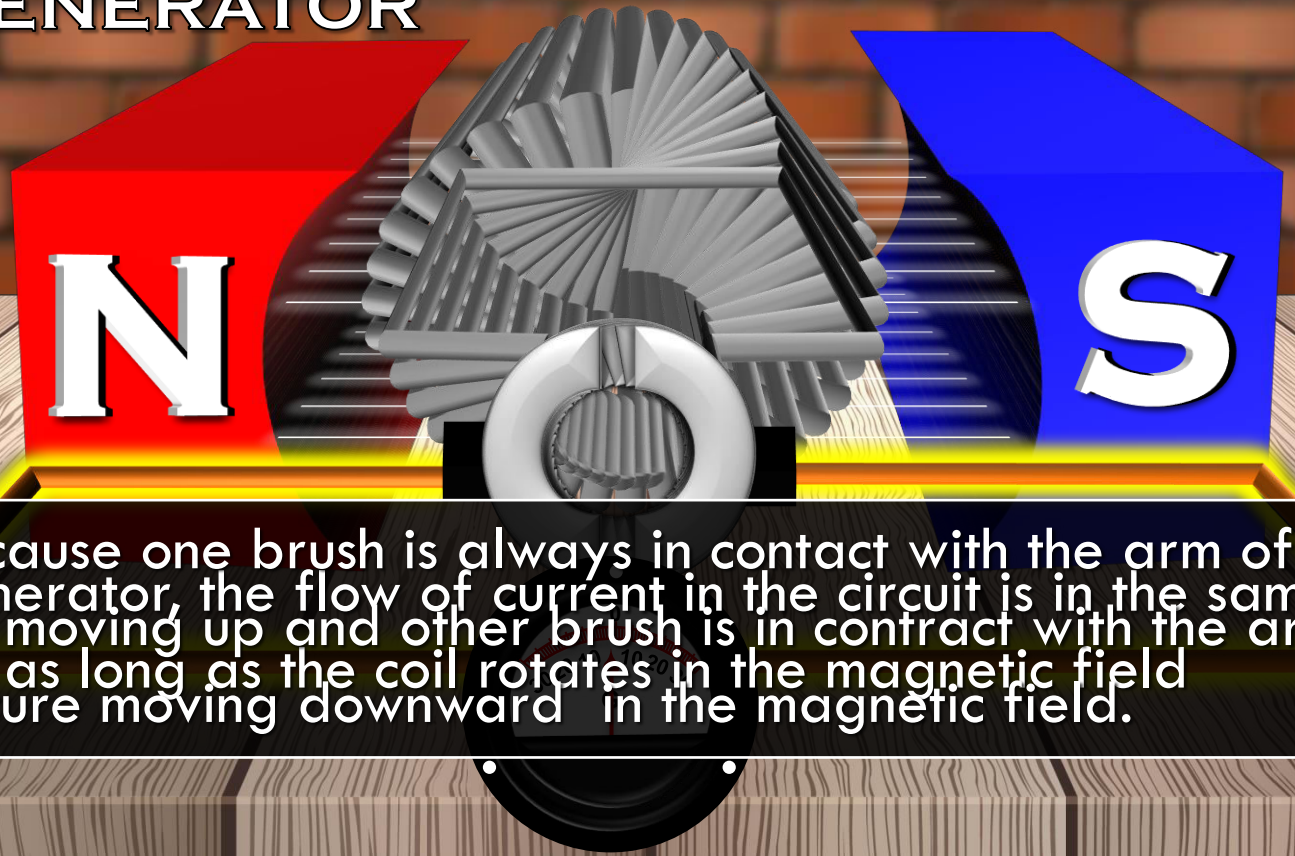
5. In the first half cycle, current flows from brush B_1 to B_2
6. In the next half cycle, current flows from brush B_2 to B_1



7. Such a current changes its direction periodically
8. The current produced is called Alternating current
9. Hence, this generator is called an AC generator

DC GENERATOR *(DYNAMO)*

DC GENERATOR



In DC generator, the flow of current in the circuit is in the same Direction as long as the coil rotates in the magnetic field

This is because one brush is always in contact with the arm of the armature moving up and other brush is in contract with the arm of the armature moving downward in the magnetic field.

DC GENERATOR

The main components of DC generator are

Armature coil **Strong magnet**

Split rings or commutator

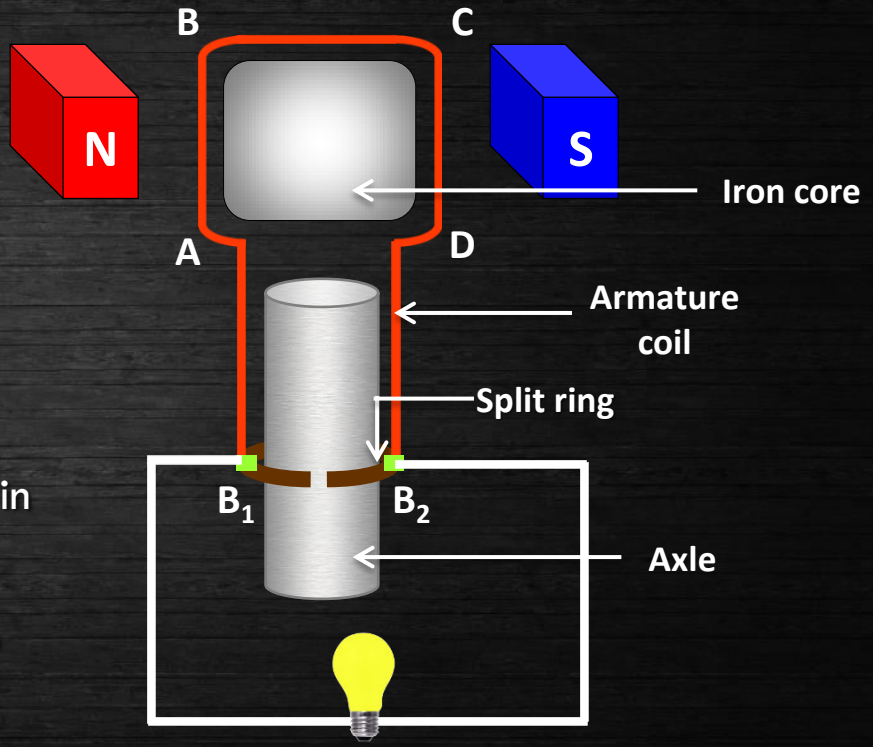
Brushes **Bulb**

The components such as armature coil, strong magnet, brushes are the same which are used for AC generators.

Split rings or commutator is the same as used in electric motor.

Bulb: The output is shown by the glowing bulb connected across the carbon brushes.

- CONSTRUCTION



Choose the correct option:

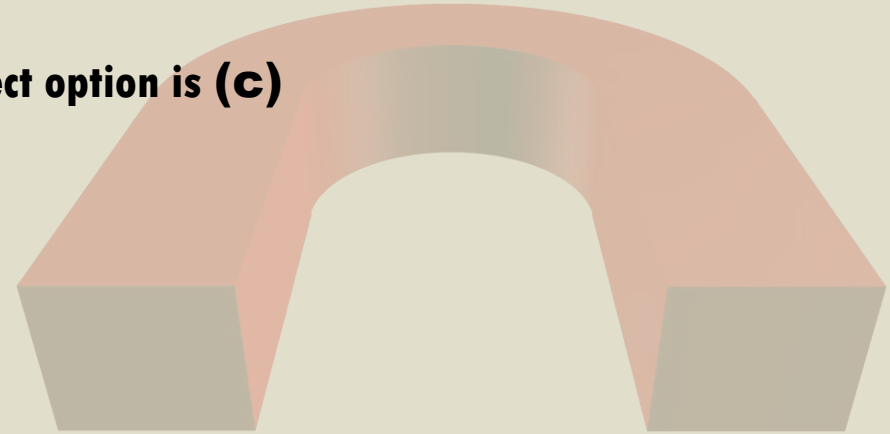
A rectangular coil of copper wires is rotated in a magnetic field. The direction of the induced current changes once in each

Q.

(a) two revolutions **(b) one revolution**

(c) half revolution **(d) one-fourth revolution**

Ans. The correct option is **(c)**



Thank You

LECTURE 6

Q. Name the following diagrams and explain the concept behind them.

Fleming's Right Hand Rule

Stretch the thumb, the forefinger and the middle finger of your right hand in such a way that they will be perpendicular to each other.

If the thumb is in the direction of motion of the conductor, the forefinger is in the direction of the magnetic field, then the middle finger shows the direction of the induced current.

It is used to find direction of induced current.

Fleming's Left Hand Rule

Stretch the thumb, the forefinger and the middle finger of your left hand in such a way that they will be perpendicular to each other.

If the forefinger is in the direction of the magnetic field, and the middle finger is in the direction of the current then the thumb shows the direction of the force on the conductor.

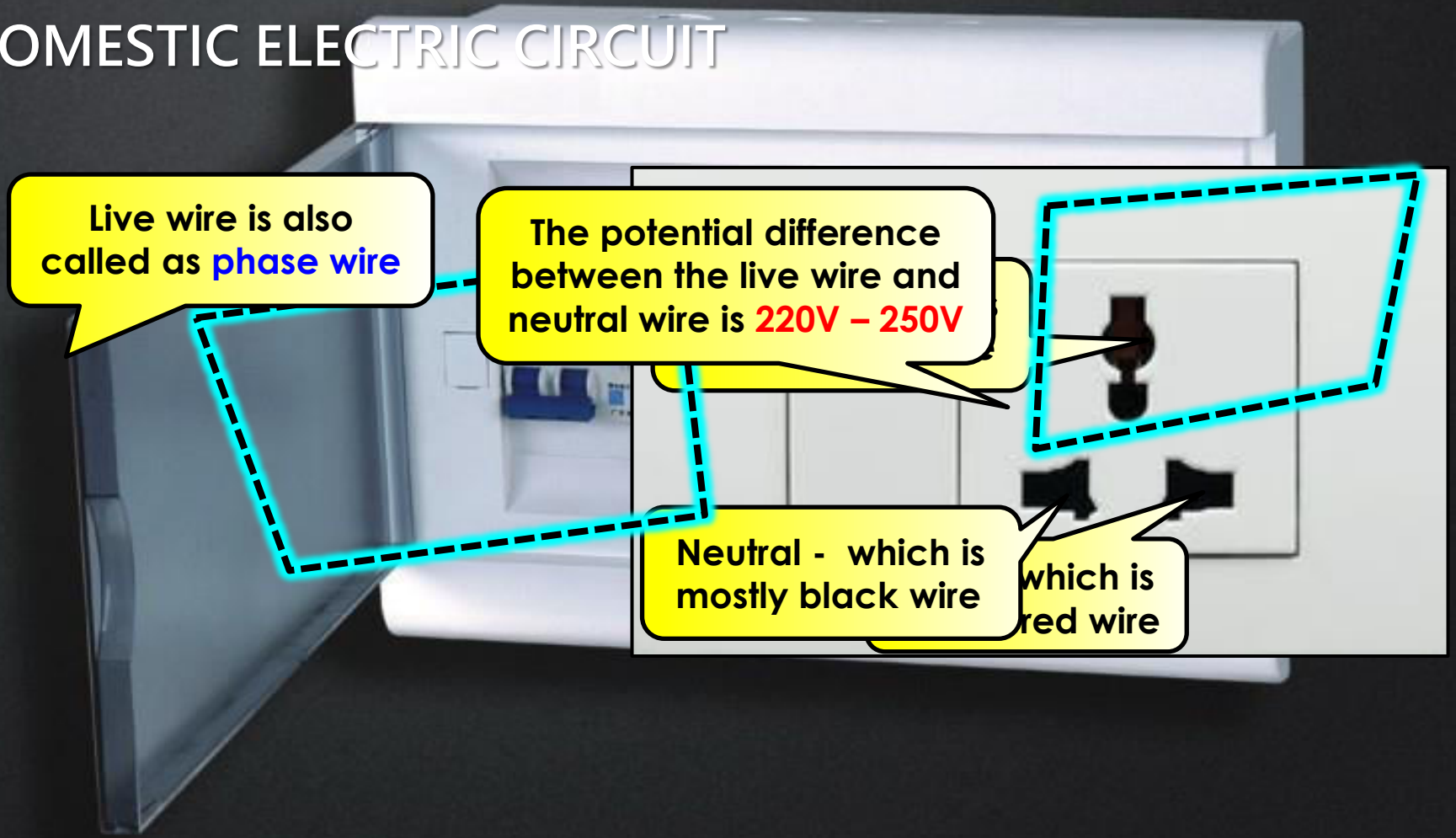
It is used to find direction of force on the conductor.

Difference between AC generator and DC motor

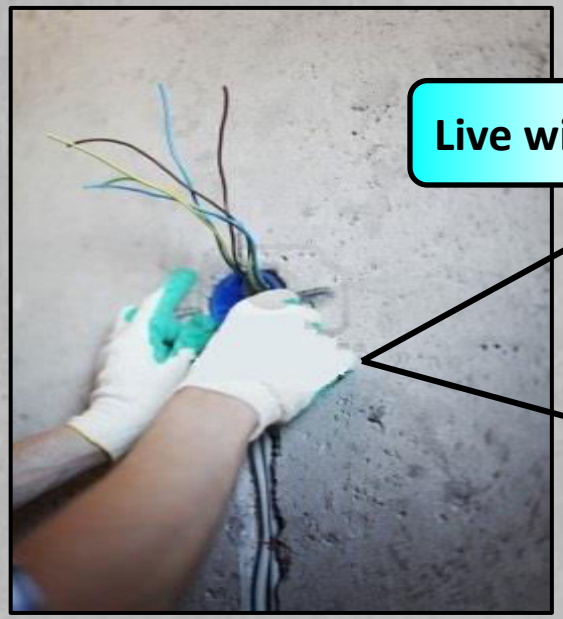
AC generator	DC motor
1. It converts mechanical energy into electrical energy.	1. It converts electrical energy into mechanical energy
2. Works on the principle of electro-magnetic induction.	2. Works on the principle of force acting on a current carrying conductor placed in a magnetic field.
3. Coil is rotated in a magnetic field so as to produce electric current	3. Current from a d.c. source flows in the coil placed in a magnetic field due to which the coil rotates.
4. Makes use of two separate coaxial slip rings.	4. Makes use of two split rings.


Ways of increasing speed of rotation of the Coil
BikeWalls.com

DOMESTIC ELECTRIC CIRCUIT



Short circuit



Live wire

Neutral wire

Resistance → less

Current → High

High current can cause sparking and fire.

ELECTRIC FUSE

MAIN SUPPLY

230 V supply

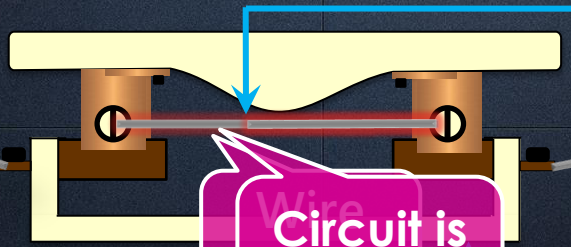
Short - circuit
(very large current flows)

Domestic voltage in our house is around 220 V – 240 V

An electric fuse protects circuits and appliances by stopping the flow of excess current.

Wire of Lead and Tin (Low Melting Point)

Appliance is protected from damage

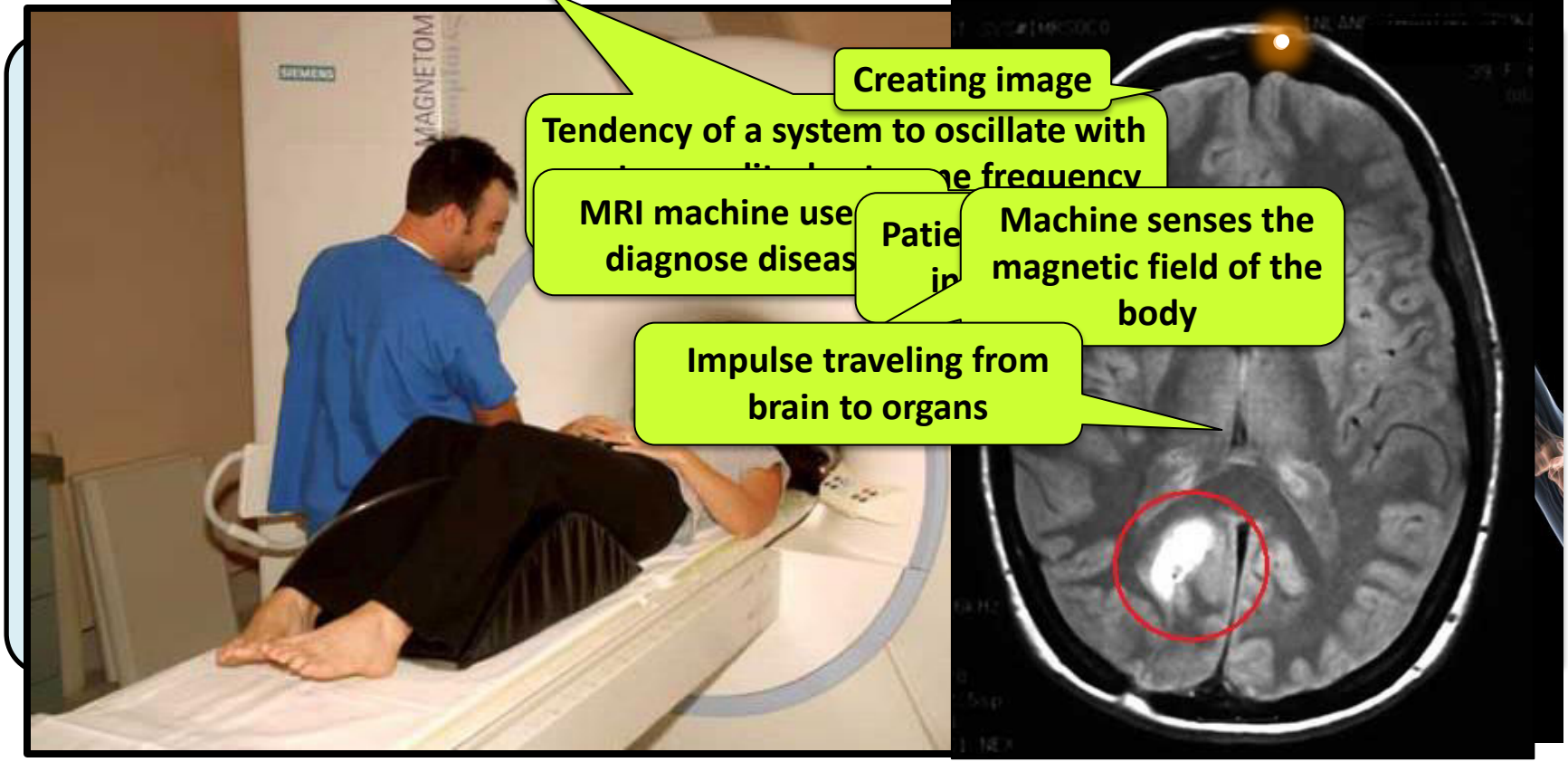


Wire melts

Circuit is broken

Porcelain Body

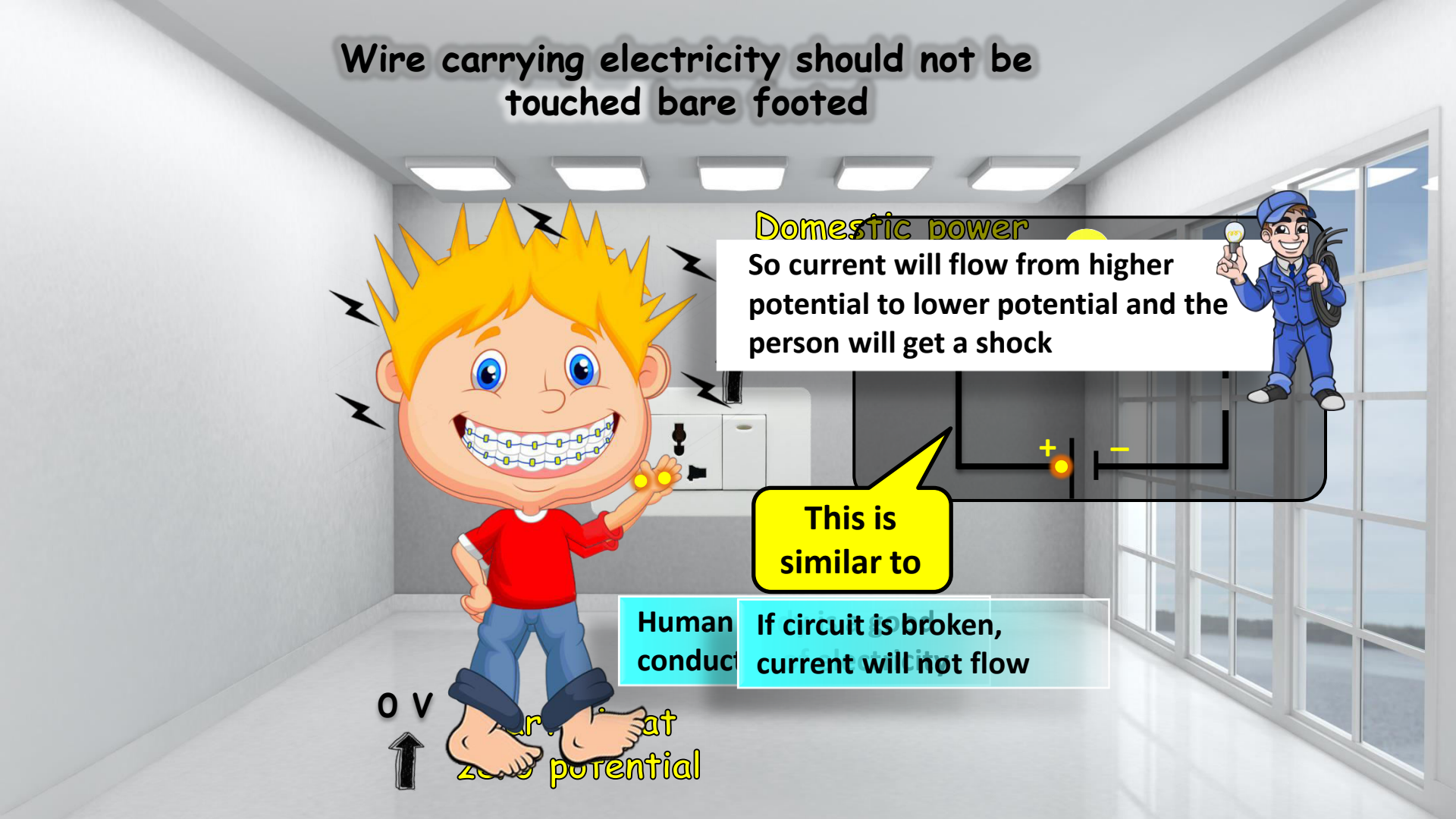
(M R I) Magnetic Resonance Imaging



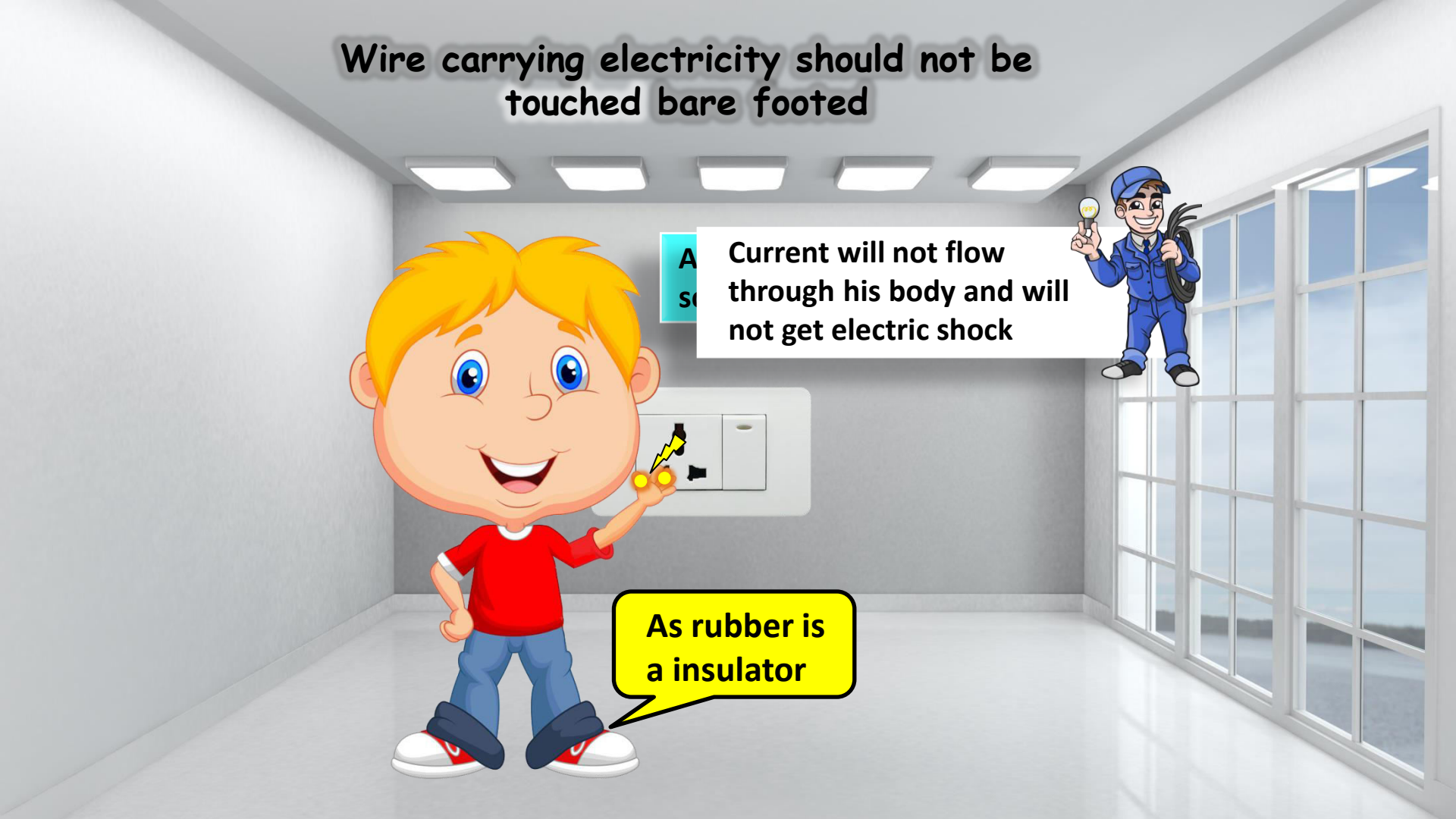
Thank You

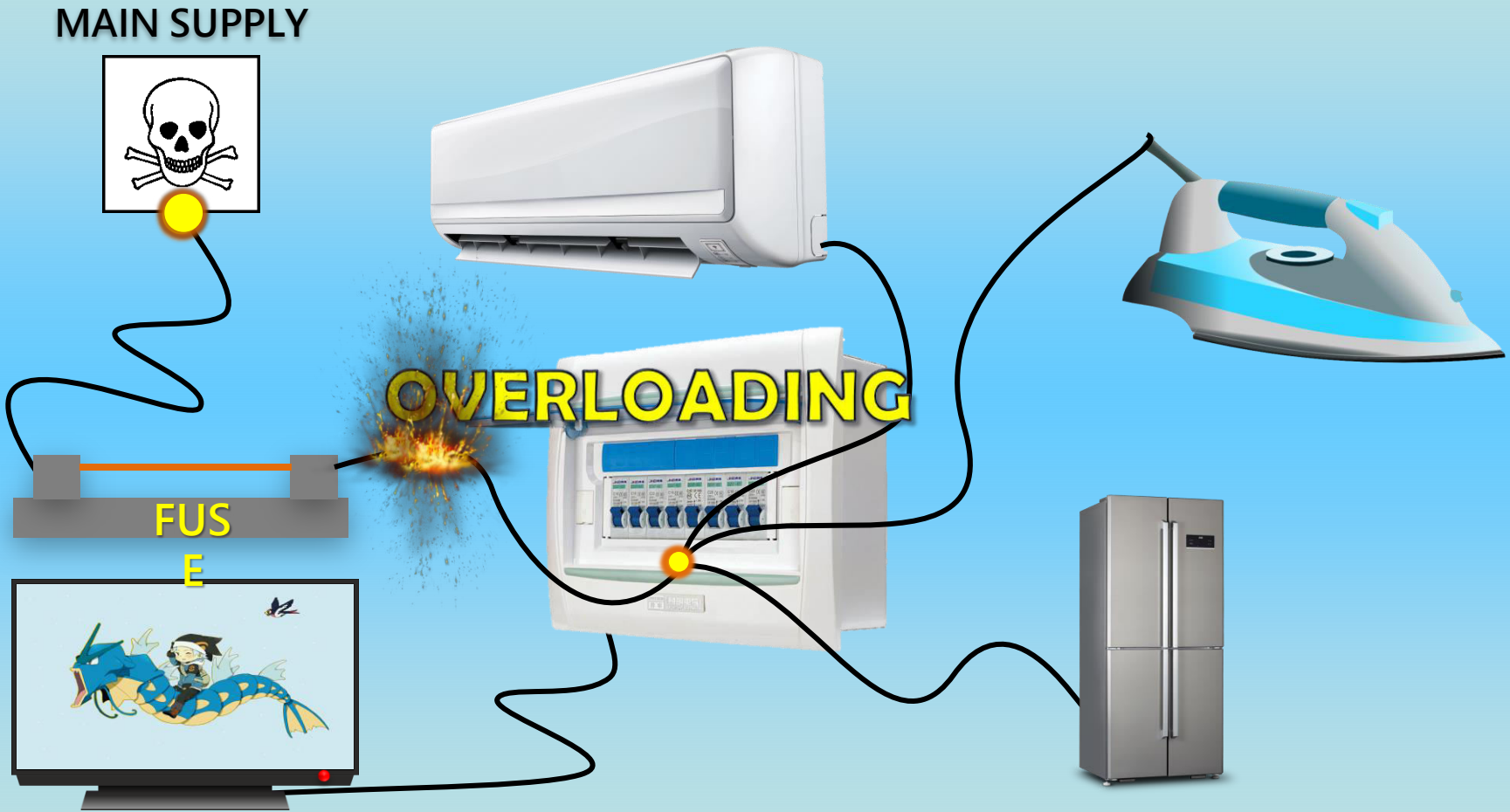
LECTURE 7

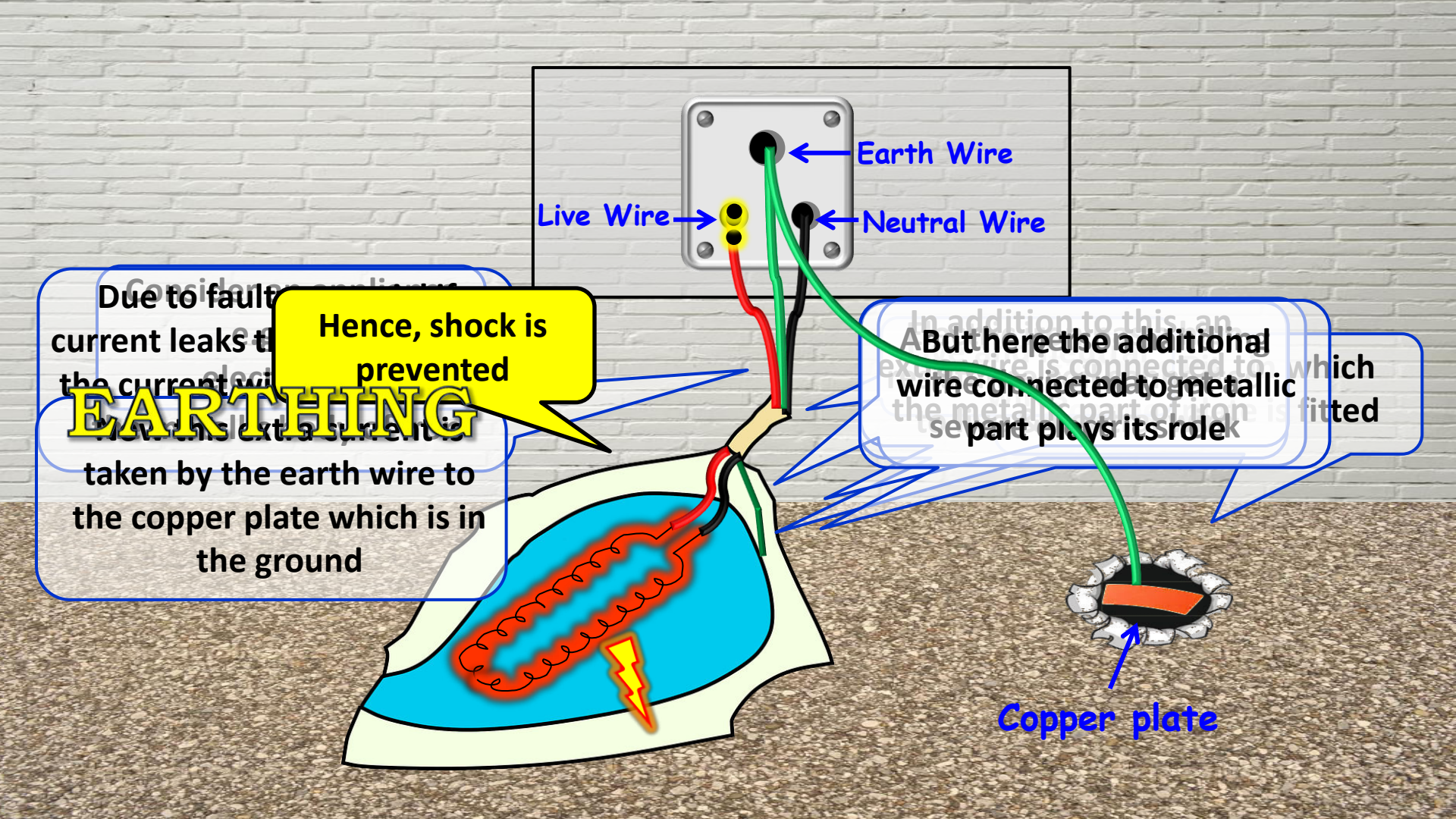
Wire carrying electricity should not be touched bare footed



Wire carrying electricity should not be touched bare footed




MAIN SUPPLY
OVERLOADING
FUS
E


Earth Wire
Live Wire
Neutral Wire
Due to fault
current leaks
taken by the earth wire to the copper plate which is in the ground
Hence, shock is prevented
EARTHING
But here the additional wire connected to metallic
part plays its role
fitted
Copper plate

In rainy season, roof and walls of a building are wet so they become good conductor of electricity.

Electric circuits should be switched off during lighting. This will save the electrical appliances from burning.

What precaution should be taken to avoid the overloading of domestic electric circuits?

Ans.

As a result of overloading, the connecting wires get over-heated and the appliances may get damaged. To avoid this, the following safety measures must be taken:

i. The wires used in the circuit must be coated with good insulating materials like PVC, etc.
ii. The circuit must be divided into different sections and a safety fuse must be used in each section.
iii. High power appliances like air-conditioner, refrigerator, water heater, etc., should not be used simultaneously.

Q. **Name two safety measures commonly used in electric circuits and appliances.**

Ans.

1. Earthing
2. Electric fuse

Q.

At the time of short circuit, the current in the circuit

a) reduces substantially.
b) does not change
c) increases heavily.
d) vary continuously.

Ans.

C) increases heavily.

Q. **An electric oven of 2 kW power rating is operated in a domestic electric circuit (220 V) that has a current rating of 5 A. What result do you expect? Explain.**

Ans. The electric oven draws a current given by

$$I = \frac{P}{V} = \frac{2\ kW}{220V} = \frac{2000\ W}{220V} = 9.09\ A$$

Thus the electric oven draws current much more than the current rating of **5** A. That is the circuit is overloaded. Due to excessive current, the fuse wire blows and the circuit is broken.

Q.

Which of the following correctly describes the magnetic field near a long straight wire?

(a) The field consists of straight lines perpendicular to the wire.

(b) The field consists of straight lines parallel to the wire.

(c) The field consists of radial lines originating from the wire.

(d) The field consists of concentric circles centered on the wire.

Ans.

(d). The field consists of concentric circles centered on the wire.

Q.

The phenomenon of electromagnetic induction is

a) **the process of charging a body.**
b) **the process of generating magnetic field due to a current passing through a coil**
c) **producing induced current in a coil due to relative motion between a magnet and the coil.**
d) **the process of rotating a coil of an electric motor.**

Ans.

(c). Producing induced current in a coil due to relative motion between a magnet and the coil.

The device used for producing electric current is called a

a) generator
b) galvanometer
c) ammeter
d) motor

Q.

Ans.

a) generator

Q.

The essential difference between an AC generator and DC generator is that

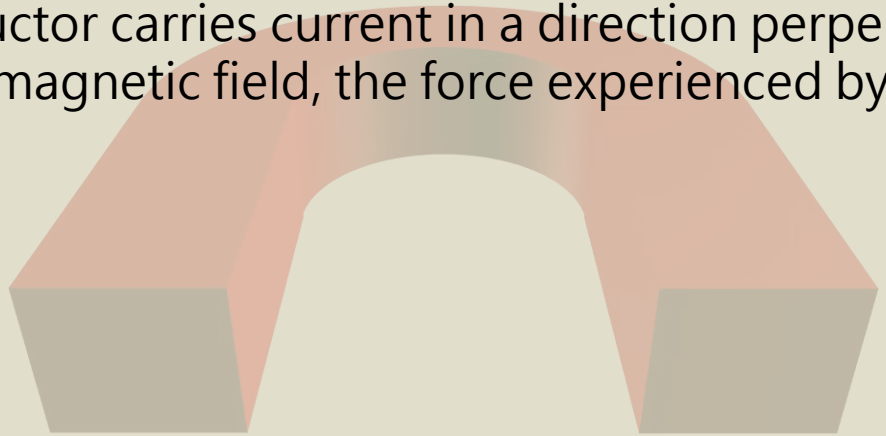
a) **AC generator has an electromagnet while a DC generator has a permanent magnet.**
b) **DC generator will generate a higher voltage.**
c) **AC generator will generate a higher voltage.**
d) **AC generator has slip rings while the DC generator has a commutate.**

Ans. **(d). AC generator has slip rings while the DC generator has a commutate.**

Q. When is the force experienced by a current-carrying conductor placed in a magnetic field largest?

Ans.

When the conductor carries current in a direction perpendicular to the direction of the magnetic field, the force experienced by the conductor is largest.



A coil of insulated copper wire is connected to a galvanometer. What will happen if a bar magnet is (i) pushed into the coil, (ii) withdrawn from inside the coil, (iii) held stationary inside the coil?

Q.

Ans.

1. An electric current is induced in the coil and the galvanometer shows a deflection.
2. An electric current is induced in the coil but in opposite direction. The galvanometer shows a deflection in reverse direction.
3. No current is induced in the coil. The galvanometer shows no deflection.

Thank You