	INDIAN SCHOOL AL WADI AL KABIR Department: SCIENCE 2021 – 22 SUBJECT: PHYSICS	
CLASS 10 HANDOUTS	Topic: MAGNETIC EFFECTS OF ELECTRIC CURRENT	NOTE: A4 FILE FORMAT
NAME OF THE STUDENT	CLASS / SEC	ROLL NO.

Magnetic effects of electric current

The production of magnetic field due to the passage of electric current in a conductor is called magnetic effect of electric current.

List some properties of magnets

a) A freely suspended magnet always points in the north- south direction.
b) A magnet attracts substances like iron, steel, cobalt, nickel etc.
c) Like magnetic poles repel each other and unlike magnetic poles attract each other.
d) Magnetic poles always exist in pairs.

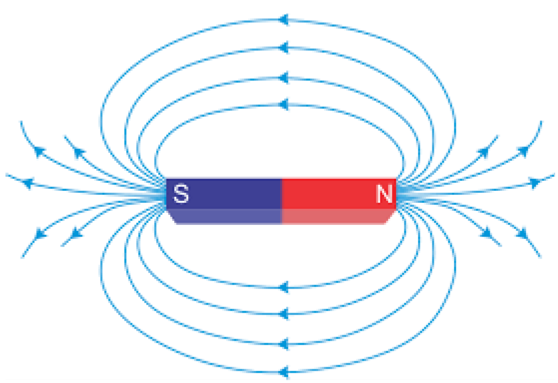
MAGNETIC FIELD

The region surrounding the magnet in which the force of magnet can be experienced is called magnetic field.

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

A. Both the magnet and magnetic compass have a magnetic field surrounding it. When brought nearer these two magnetic fields interfere each other and exert a force on each other. This force makes the compass needle deflect.

PROPERTIES OF MAGNETIC FIELD LINES AROUND A BAR MAGNET



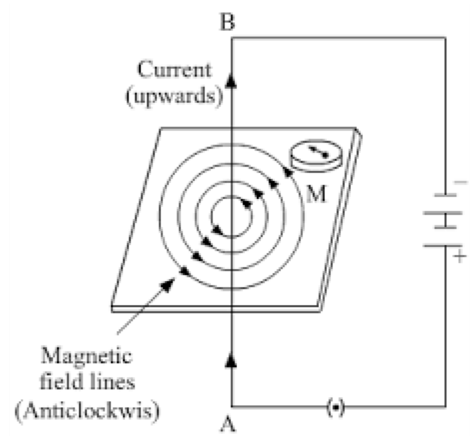
a) Each magnetic field line forms a closed curve
b) The relative strength of the magnetic field is shown by the degree of closeness of the field lines.
c) No two magnetic field lines can intersect each other. This is because if they do so at the point of intersection the north pole of the compass needle point in two different directions showing two directions of magnetic field at a given point, which is not possible.

d) The magnetic field lines emerge from north pole and merge at south pole outside the magnet.
e) The magnetic field lines move from South Pole to the North Pole inside the magnet.

MAGNETIC FIELD LINES/ MAGNETIC LINES OF FORCE

The imaginary lines through which the magnetic force acts

PROPERTIES OF MAGNETIC FIELD LINES AROUND A STRAIGHT CURRENT CARRYING CONDUCTOR



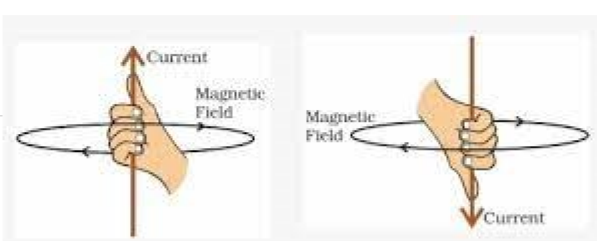
- Magnetic field lines are concentric circles surrounding the straight current carrying conductor.
- If the direction of the current in the wire is reversed the direction of the magnetic field lines also get reversed.
- When the direction of the current is downwards the direction of the magnetic field is clockwise.
- When the direction of the current is upwards the direction of the magnetic field is anti-clockwise.

FACTORS ON WHICH THE STRENGTH OF THE MAGNETIC FIELD DUE TO CURRENT CARRYING STRAIGHT CONDUCTOR DEPEND ON

- Depends directly on the current passing through the conductor.
- Depends inversely on the distance from the conductor.

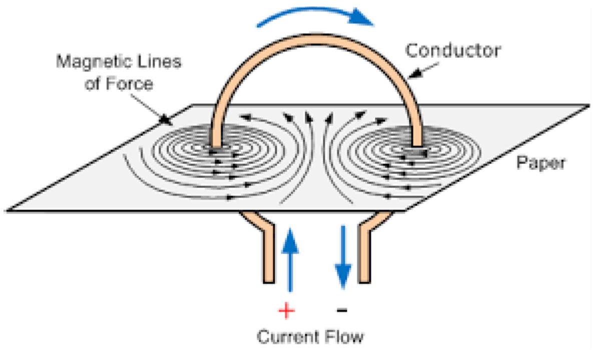
RULE TO FIND THE DIRECTION OF MAGNETIC FIELD DUE TO A CURRENT CARRYING STRAIGHT CONDUCTOR

RIGHT HAND THUMB RULE



Imagine that you are holding a current carrying straight conductor in your right hand such that the thumb points towards the direction of the current. Then your fingers will wrap around the conductor in the direction of the field lines of the magnetic field.

<u>PROPERTIES OF MAGNETIC FIELD LINES AROUND A CURRENT CARRYING CIRCULAR LOOP</u>



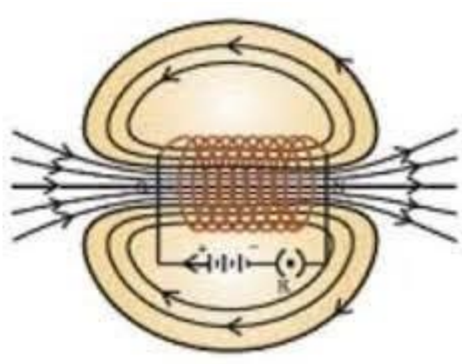
- **The magnetic field lines are nearly circular near the wire.**
- **They are in the same direction within the space enclosed by the wire.**
- **Near the centre of the loop the magnetic field lines are nearly parallel and straight, showing that the magnetic field is uniform.**

<u>FACTORS ON WHICH THE STRENGTH OF THE MAGNETIC FIELD DUE TO CURRENT CARRYING CIRCULAR LOOP DEPEND ON</u>

- **Strength of the magnetic field increases with increase in the strength of the current.**
- **Strength of the magnetic field decreases with increase in the radius of the loop.**

<u>SOLENOID</u>

A solenoid is a coil of insulated copper wire wound closely in the form of a cylinder. When current is passed through this it acts like a magnet.



<u>FACTORS ON WHICH THE STRENGTH OF THE MAGNETIC FIELD DUE TO CURRENT CARRYING SOLENOID DEPEND ON.</u>

- **Strength of the magnetic field increases with increase in the strength of the current.**
- **Strength of the magnetic field decreases with increase in the radius of the loop.**
- **Strength of the magnetic field increases with increase in the number of turns of the coil.**

- **Strength of the magnetic field depends on the nature of the core material inserted along the axis of the solenoid.**

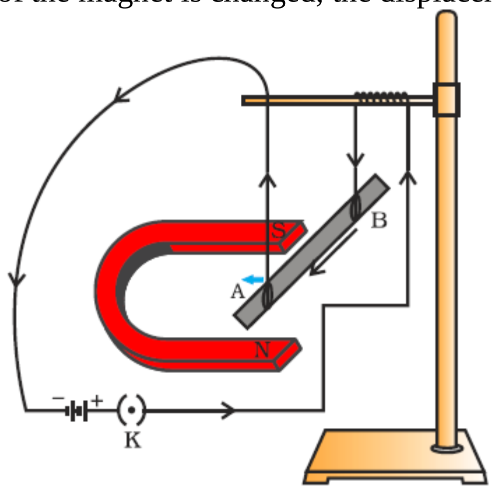
(All the diagrams of the above mentioned topics should be practised in the Physics class work)

Force on a current carrying conductor

A current carrying conductor kept in a magnetic field produces a force on the conductor.

Activity to prove that a force is exerted on a current carrying conductor kept in a magnetic field

An Aluminium rod AB is suspended horizontally from a stand as shown in the figure. Place a horse shoe magnet near it as shown in the figure. When the current flows through this conductor it is observed that the rod gets displaced towards one side and when the polarity of the current is reversed, or the poles of the magnet is changed, the displacement of the rod also gets reversed.



- The direction of displacement or the direction of force depends on the direction of current or the direction of magnetic field.

- The magnitude of the force is highest when the direction of electric field and magnetic field is perpendicular to each other.

Fleming's left-hand rule: -

Fleming's left-hand rule is used to determine the direction of force acting on a current carrying conductor kept in a magnetic field or the direction of motion of the conductor.

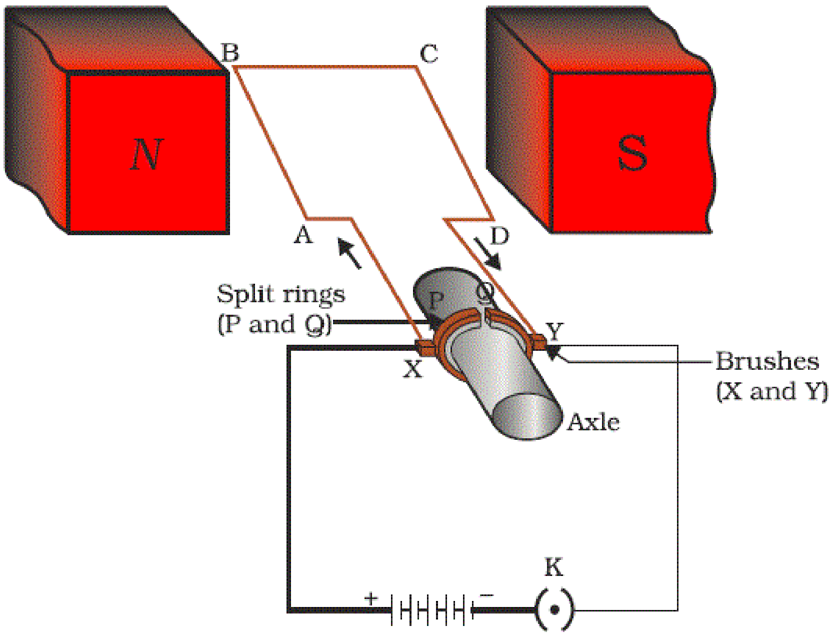
- It is used to the find the direction of force when the direction of current and the direction of magnetic field acting on the conductor is known.
- According to this rule, stretch the thumb, forefinger and middle finger of your left hand such that they are mutually perpendicular, then if the forefinger points in the direction of magnetic field and the middle finger in the direction of current, then the thumb will point in the direction of motion or the force acting on the conductor.

Electric motor

An electric motor is a device which converts electrical energy to mechanical energy. Therefore, it isused in fans, mixers, grinders, washing machines etc.

An electric motor consists of a rectangular coil ABCD of insulated copper wire. The soft ironcore, on which the coil is wound, plus the coils, is called an armature. The coil is placed between the two poles of a magnetic field such that the arm AB and CD are perpendicular to the direction of the magnetic field. The ends of the coil are connected to the two halves P andQ of a split ring.

The inner sides of these halves are insulated and attached to an axle. The external conducting edges of P and Q touch two conducting stationary brushes X and Y, respectively.



A device that reverses the direction of flow of current through a circuit is called a commutator. In electric motors, the split ring acts as a commutator. The reversal of current also reverses the direction of force acting on the two arms AB and CD. The reversing of the current is repeated at each half rotation, giving rise to a continuous rotation of the coil and tothe axle.

PRINCIPLE ON WHICH ELECTRIC MOTOR WORKS

It works on the principle that a force is exerted on a current carrying conductor kept in amagnetic field and its direction is given by FLEMING's LEFT AND RULE

ELECTROMAGNETIC INDUCTION

In 1831, Faraday made an important breakthrough by discovering how a moving magnet can be usedto generate electric currents**.**

The PRODUCTION OF INDUCED CURRENT in a coil kept in a varying magnetic field is knownas **electromagnetic induction.**

Activity I to prove electromagnetic induction:-

Take a coil of wire AB having a large number of turns.

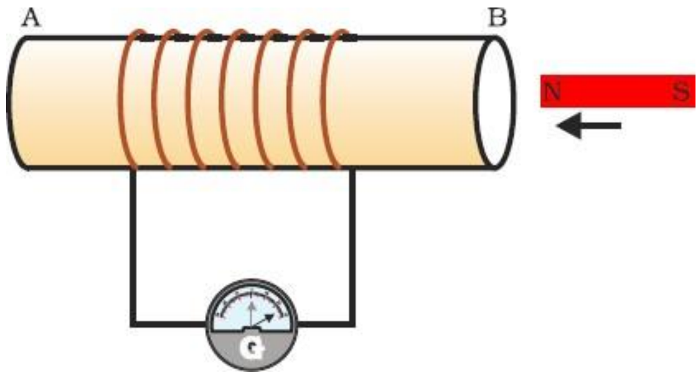
□ Connect the ends of the coil to a galvanometer as shown in the Figure.

□ Take a strong bar magnet and move its north pole towards the end B of the coil. There is a momentary deflection in the needle of the galvanometer, say to the right. This indicates the presenceof a current in the coil AB. The deflection becomes zero the moment the motion of the magnet stops.

□ Now withdraw the north pole of the magnet away from the coil. Now the galvanometer is deflected toward the left, showing that the current is now set up in the direction opposite to the first.

□ Place the magnet stationary at a point near to the coil, keeping its north pole towards the end B ofthe coil. We see that the galvanometer needle deflects toward the right when the coil is moved towards the north pole of the magnet. Similarly, the needle moves toward left when the coil is movedaway.

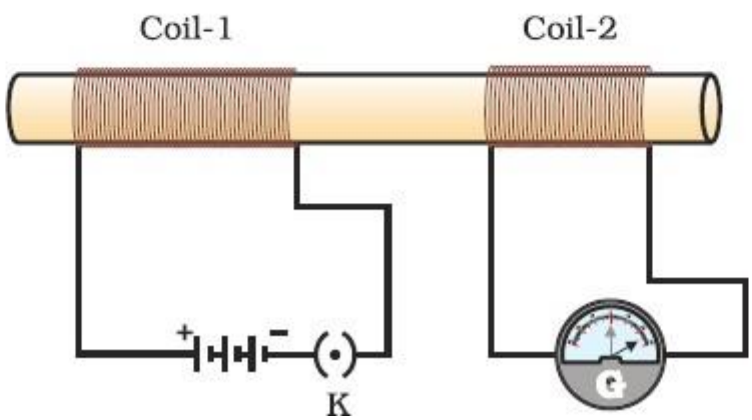
□ When the coil is kept stationary with respect to the magnet, the deflection of the galvanometerdrops to zero.



Inference: The relative motion of a magnet with respect to the coil or vice versa induces a potentialdifference in the coil and therefore an induced current in the circuit.

Activity II to prove electromagnetic induction:-

- Take two different coils of copper wire having large number of turns. Insert them over a non-conducting cylindrical roll as shown in the diagram.
- Connect coil 1 having large number of turns in series with a battery and a plug key. Alsoconnect coil 2 with a galvanometer.
- Plug in the key and observe the galvanometer. The needle of the galvanometer shows amomentary deflection to one side.
- When we disconnect the coil from the battery there is again a momentary deflection in thegalvanometer to the opposite side.



Inference :- Electric current is induced in the second coil whenever there is a varying magnetic field is associated with it and that is induced momentarily when the current isswitched on or off in the first coil.

Fleming's right hand rule

Fleming's right hand rule is used to know the direction of induced current produced in a straight conductor (or wire) moving in a magnetic field.

- According to this rule, stretch the thumb, forefinger and middle finger of right hand so that they are perpendicular to each other. If the forefinger indicates the direction of the magneticfield and the thumb shows the direction of motion of conductor, then the middle finger willshow the direction of induced current.

PREPARED BY Mrs. JENESHA JOSEPH	Checked by: HOD - SCIENCE