CLASS 10 NOTES

SCIENCE

Magnetic Effects

PRASHANT KIRAD

Magnetic Effects of Electric Current

Hans Christian Oersted found that if you put a compass next to a wire with an electric current flowing through it, the needle in the compass would move. He thought this happened because the electric current created a magnetic field, which caused the compass needle to deflect.

Magnetic fields:

The region around a magnet where a magnetic force is felt is called the magnetic field. It's a vector quantity, and its unit in the International System of Units (SI) is the tesla.

Magnetic field Lines:

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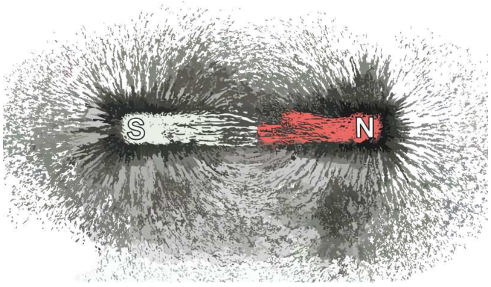
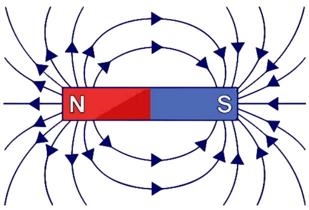
Imaginary lines that depict the magnetic field are observed when iron fillings are placed near a magnet, forming a pattern that illustrates the arrangement of magnetic field lines.

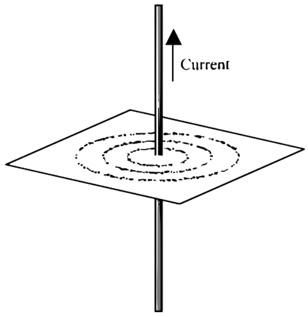




- Magnetic field lines start at the North pole of a magnet and extend to the South pole outside the magnet. However, within the magnet, the direction is from South to North.
- They create unbroken, closed curves.
- The tangent indicates the direction of the magnetic field at any point on the magnetic field lines.
- Magnetic field lines never intersect each other.
- When magnetic field lines are closely spaced, the magnetic field is stronger. Conversely, the magnetic field is weaker if the field lines are spaced farther apart.

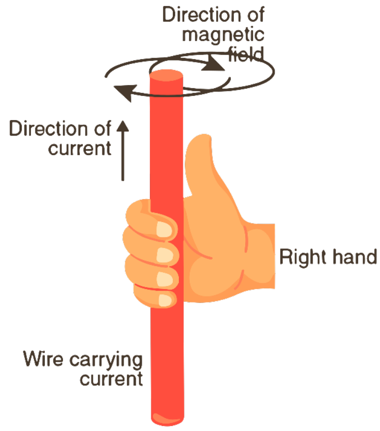
The magnetic field is produced by a current flowing through a straight conductor.

- Magnetic field lines form concentric circles with the center at the wire.
- The strength of the magnetic field increases with an increase in current.
- The strength of the magnetic field decreases as we move away from the wire.



Maxwell's Right-Hand thumb Rule: ← E.M.A

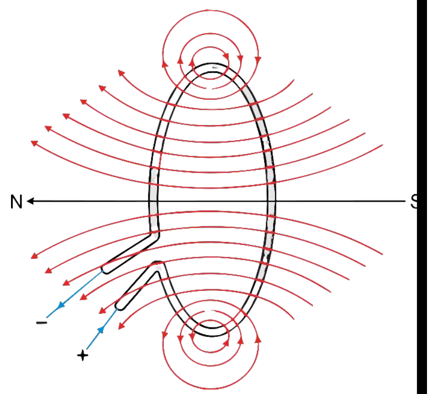
Maxwell's Right-Hand Thumb Rule helps you find the direction of the magnetic field around a wire with current. Point your thumb in the direction of the current, and the way your fingers curl shows the magnetic field's direction.



Magnetic field due to a current through a circular Loop:

When current flows through a circular loop:

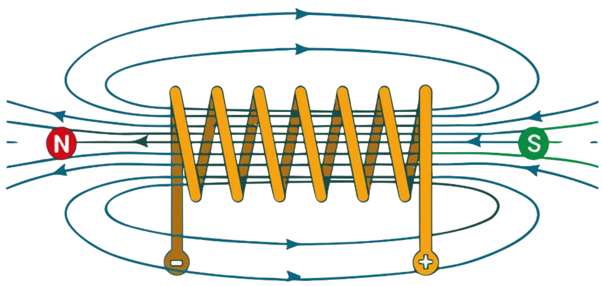
1. Inside the loop, the magnetic field runs along the axis.
2. Outside the loop, it forms concentric circles.
3. The field's strength depends on the current and loop size.
4. The direction inside is determined by the current using the right-hand rule.



Magnetic field due to current in a solenoid: ← E.M.A

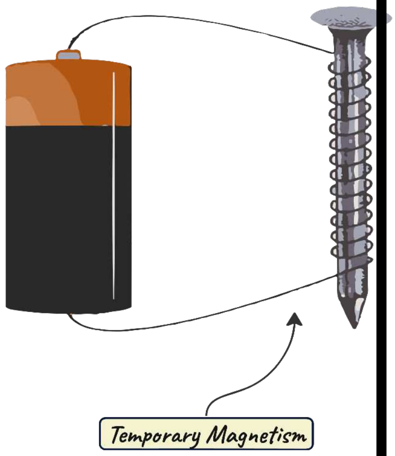
When current flows through a solenoid

1. Magnetic field lines run through the core.
2. It resembles the magnetic field around a bar magnet.
3. Strength depends on current and the number of turns in the solenoid.
4. The field's direction is determined by the right-hand rule.



Electromagnet:

An electromagnet is a temporary magnet created by passing an electric current through a coil of wire. It exhibits magnetic properties only when the current flows, making it useful in various applications like doorbells and electric locks. The strength of the electromagnet can be adjusted by changing the current or the number of coils in the wire.



Force on a current-carrying conductor in a magnetic field:

When a current-carrying conductor is placed in a magnetic field:

1. It experiences a force perpendicular to both the current direction and the magnetic field direction.
2. The force's strength increases with the amount of current and the strength of the magnetic field.
3. The direction of the force is determined by Fleming's Left-Hand Rule, where the thumb represents motion, the forefinger indicates magnetic field, and the middle finger denotes current direction.

#Fleming's Left Hand rule: E.M.A

Fleming's Left-Hand Rule is a way to figure out the direction of three things: the magnetic field (first finger), the current (second finger), and the force or motion (thumb).
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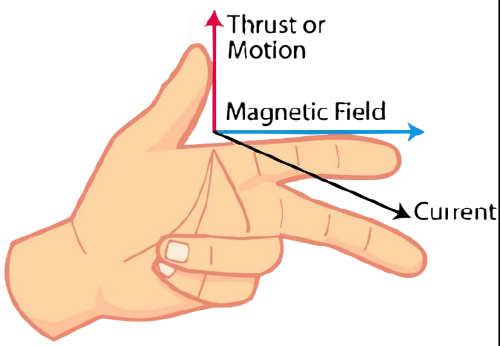
Imagine holding your left hand with your thumb, first finger, and second finger at right angles to each other. If you point your first finger in the direction of the magnetic field, and the second finger in the direction of the current, then your thumb will point in the direction of the force or motion. It helps to remember how these three things are related in a magnetic field.



Secret Questions

1) Why do two magnetic field lines not intersect?

Solution: Magnetic field lines do not intersect because if they did, it would imply that at the point of intersection, a compass needle would need to show two different directions simultaneously, which is not possible.

2) What is meant by the term, 'magnetic field'? Why does a compass needle show deflection when brought near a bar magnet?

Solution: The magnetic field is the space surrounding a magnet where a magnetic material feels a force due to that magnet. The compass needle, acting like a small bar magnet, enters the magnetic field of another bar magnet. As a result, the needle encounters a force from the bar magnet, causing it to deflect.

3) Name and state the rule that determines the direction of the magnetic field around a straight current-carrying conductor.

Solution: The Right-Hand Thumb Rule involves holding a current-carrying straight conductor in your right hand with the thumb pointing in the direction of the current. The fingers then wrap around the conductor in the direction of the magnetic field lines.

4) Why are magnetic field lines more crowded towards the pole of the magnet?

Solution: Magnetic field lines are more crowded towards the poles of a magnet because the magnetic field is stronger in those regions due to the convergence of field lines, indicating higher magnetic force.

5) List two sources of magnetic fields.

Solution: a. Permanent Magnets Materials like iron, nickel, and cobalt can be magnetized, creating permanent magnets.

b. Electric Currents: Flowing electric currents create magnetic fields.

Galvanometer:

A device capable of sensing the presence of an electric current in a circuit. The needle stays at the zero position (center of the scale) when there is no current. Depending on the current direction, the pointer can shift to either the left or right of the zero mark on the scale.

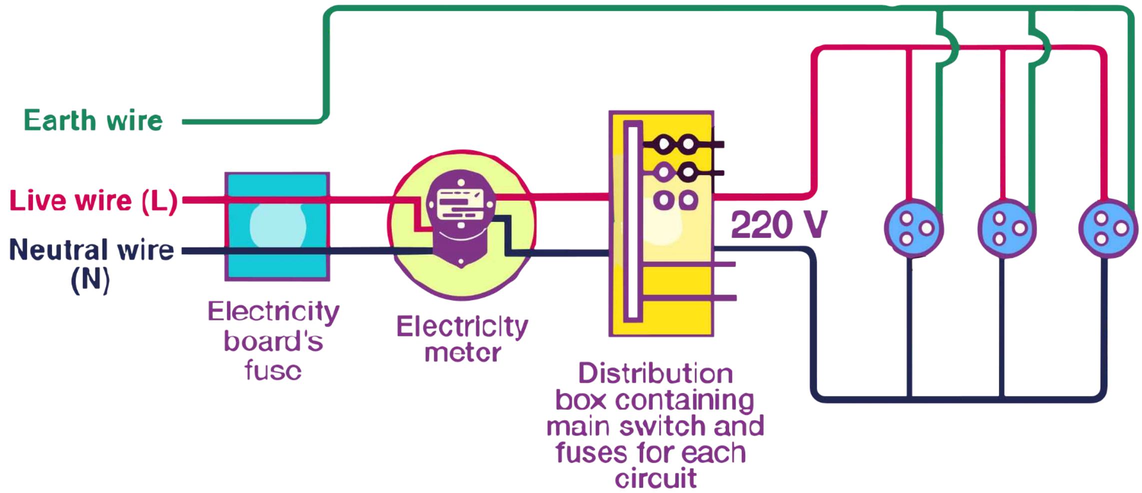
Types of Current

- Direct current or D.C
  - It is the electric current which flows in the same direction.
- Alternatin current or A.C
  - It is the electric current which reverses its direction after every fixed interval oij time.

Domestic Circuit: ← E.M.A

- Electricity generated at power stations is conveyed to our homes through two robust copper or aluminum wires.
- One of these wires is known as the live wire, distinguished by its red insulation cover, and it operates at a voltage of 220 V with a frequency of 50 Hz.
- The other is termed the neutral wire, identifiable by its black insulation cover, and it is at zero potential.
- The live and neutral wires enter an electricity meter, commonly installed in homes, through a primary fuse.
- They are linked to the line wires in the home through a primary switch.

- Each distribution circuit is equipped with an individual fuse. In the event of a fault, such as a short circuit in one circuit, its respective fuse blows, while the other circuit remains unaffected.



Domestic Electric Circuit

- All electric appliances, such as bulbs and fans, are connected in parallel across the live wire and neutral wire.

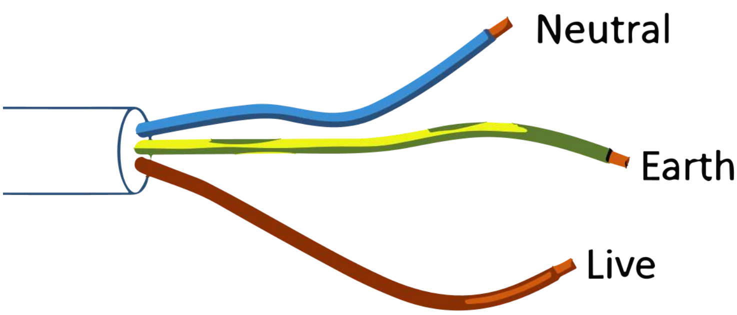
The electric supply reaching our homes has two wires:

1. Live Wire (Phase Wire): Typically colored red or brown, it carries the current from the power source to the electrical appliances.

2. Neutral Wire: Usually blue or black, it completes the circuit by providing a return path for the current to flow back to the power source.

EARTH WIRE:

The earth wire, often green or bare, is a safety wire in electrical circuits. It provides a path for excess electrical current to safely flow into the ground, preventing electric shocks and ensuring safety in case of faults.



Fuse:

A safety device made of a thin wire composed of a tin and lead alloy with a low melting point. Its purpose is to prevent potential damage caused by overloading and short-circuiting.

Top 7 Questions:

1) What are permanent magnets and electromagnets? Give two uses of each. [CBSE 2010]

Solution:

Permanent Magnet: It has a constant magnetic field around it. e.g. generator, loudspeaker.

Electromagnet: When a soft iron is placed in a solenoid it gets magnetized till there is current in the solenoid, e.g. electric bells, or cranes.

2) Differentiate overloading and short-circuiting. **(CBSE 2010)**

Solution:

Overloading means to draw current more than the permitted maximum current in the circuit which may be due to connecting many appliances in one socket. In short, circuiting, when live wire and neutral wire come in contact with each other then the resistance of the circuit becomes minimal consequently the current in the circuit increases abruptly. It may be due to damage to the insulation of the wire.

3) What happens to the deflection of the compass needle placed at a point near the current carrying a straight conductor: **(CBSE 2011, 2014)**

a. if the current is increased?

b. if the direction of current in the conductor is changed (reversed)?

c. if the compass is moved away from the conductor?

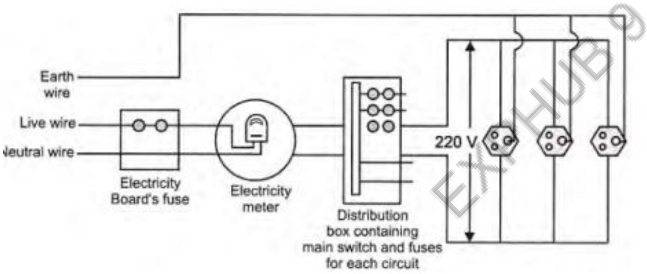
Solution:

a. If the current increases deflection of the compass increases.
b. If the direction of current is reversed the deflection in the compass needle is also reversed.
c. The deflection of the compass needle decreases when a compass is moved away from the conductor.

4) (a) Which effect of the electric current is utilized in the working of an electrical fuse?
(b) A fuse is connected in series or parallel in a household circuit? (c) Draw a schematic labeled diagram of a domestic circuit that has a provision of a main fuse, meter, one light bulb, and a switch socket.

Solution:

a. Heating effect of current
b. In series in the household circuit
C.



5) State one main difference between AC and DC. Why AC is preferred over DC for long-range transmission of electric power? Name one source for each of AC and DC. **(CBSE 2012)**

Solution:

The magnitude and direction of ac remain the same whereas a.c. changes its magnitude and direction periodically. Low AC voltage can be increased to high voltage to prevent loss of electric energy during its long-distance transmission. AC generator and DC generator/or cell.

6) (a) Mention the color code used for live, neutral, and earth wire.

(b) You want to connect a 2 kW electric oven to the electric circuit. In which power line would you connect it and why? What may happen if you connect it wrongly to the other power line?

Solution:

(a) Live wire – Red Neutral wire – Black Earth wire – Green

(b) 2 kW electric iron draws a large current. If it is connected to a socket of 5A then the fuse will be blown. So it is connected to the power socket of 15 A

7) (a) State the function of a fuse in an electric circuit. How is it connected in the domestic circuit?

(b) An electric fuse of rating 3A is connected in a circuit in which an electric iron of power 1.5 kilo watt is connected which operates at 220 V. What would happen? Explain.

Solution:

(a) Fuse is a safety device to prevent damage to electrical devices from short circuits or overloading. A fuse is connected in series with the circuit.

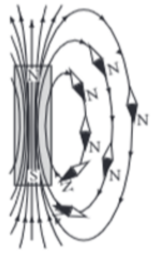
(b) Given Power $P = 1.5$ kW $= 1500$ Watt and $V = 220$ Volts.

Power $P = VI \Rightarrow I = \frac{P}{V} = \frac{1500}{220} = 6.8$ A

The rating of fuse is 3A which is lesser the current drawn by electric iron 6.8 A. So fuse wire will be blown.

Competency-based Questions:

1. A magnetic field is described by drawing the magnetic field lines. When a small north magnetic pole is placed in the magnetic field created by a magnet, it will experience a force. And if the north pole is free, it will move under the influence of magnetic field. The path traced by a north magnetic pole free to move under the influence of a magnetic field is called a magnetic field line. Since the direction of magnetic field line is the direction of force on a north pole, so the magnetic field lines always begin from the N-pole of a magnet and end on the S-pole of the magnet. Inside the magnet, however the direction of magnetic field lines is from the S-pole of the magnet to the N-pole of the magnet. Thus, the magnetic field lines are closed curves. When a small compass is moved along a magnetic field line, the compass needle always sets itself along the line tangential to it. So, a line drawn from the south pole of the compass needle to its north pole indicates the direction of the magnetic field at that point



(i) The magnetic field lines
(a) intersect at right angle to one another
(b) intersect at an angle of 45° to each other
(c) do not cross one another
(d) cross at an angle of 60° to one another.

(ii) A strong bar magnet is placed vertically above a horizontal wooden board. The magnetic lines of force will be
(a) only in horizontal plane around the magnet
(b) only in vertical plane around the magnet
(c) in horizontal as well as in vertical planes around the magnet
(d) in all the planes around the magnet.

(iii) Magnetic field lines can be used to determine
(a) the shape of the magnetic field
(b) only the direction of the magnetic field
(c) only the relative strength of the magnetic field
(d) both the direction and the relative strength of the magnetic field.

(iv) The magnetic field lines due to a bar magnet are correctly shown in figure

(v) Which of the following is not true about magnetic field lines?
(a) Magnetic field lines are the closed and continuous curve.
(b) No two field lines can cross each other.
(c) Crowdness of field lines represents the strength of magnetic field.
(d) The direction of field lines is from the north pole to the south pole inside a bar magnet.

2. An insulated copper wire wound on a cylindrical cardboard tube such that its length is greater than its diameter is called a solenoid. When an electric current is passed through the solenoid, it produces a magnetic field around it. The magnetic field produced by a current-carrying solenoid is similar to the magnetic field produced by a bar magnet. The field lines inside the solenoid are in the form of parallel straight lines. The strong magnetic field produced inside a current-carrying solenoid can be used to magnetise a piece of magnetic material like soft iron, when placed inside the solenoid. The strength of magnetic field produced by a current carrying solenoid is directly proportional to the number of turns and strength of current in the solenoid.

i) The strength of magnetic field inside a long current-carrying straight solenoid is
(a) more at the ends than at the centre
(b) minimum in the middle
(c) same at all points
(d) found to increase from one end to the other.

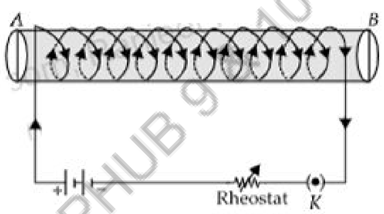
(ii) The north-south polarities of an electromagnet can be found easily by using
(a) Fleming's right-hand rule
(c) Clock face rule
(b) Fleming's left-hand rule
(d) Left-hand thumb rule.

(iii) For a current in a long straight solenoid N-and S-poles are created at the two ends. Among the following statements, the incorrect statement is

(a) The field lines inside the solenoid are in the form of straight lines which indicates that the magnetic field is the same at all points inside the solenoid.
(b) The strong magnetic field produced inside the solenoid can be used to magnetise a piece of magnetic material like soft iron, when placed inside the coil.
(c) The pattern of the magnetic field associated with the solenoid is different from the pattern of the magnetic field around a bar magnet.
(d) The N- and S-poles exchange position when the direction of current through the solenoid is reversed.

(iv) A long solenoid carrying a current produces a magnetic field B along its axis. If the current is double and the number of turns per cm is halved, then new value of magnetic field is
(a) B (b) 2B (c) 4B (d) B/2

(v) A soft iron bar is enclosed by a coil of insulated copper wire as shown in figure. When the plug of the key is closed, the face B of the iron bar marked as



(a) N–pole
(b) S–pole
(c) N–pole if current is large
(d) S–pole if current is small