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Magnetic Effects of Electric Current Class 10 Notes | CBSE Chapter 12 Science

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Magnetic Effects of Electric Current Class 10 Notes | CBSE Chapter 12 Science

Magnetic Effects of Electric Current is Chapter 12 of CBSE Class 10 Science. This chapter explores the connection between electricity and magnetism — how electric current produces a magnetic field, how this principle is used in electromagnets, electric motors, and generators, and how electricity is distributed to our homes safely.

This chapter carries 5–8 marks in board exams. Fleming's rules, the working of electric motors and generators, and domestic electric circuits are the most frequently tested topics.

Key Concepts

1. Magnetic Field and Field Lines

A **magnetic field** is the region around a magnet where its influence (force) can be felt. It is represented by **magnetic field lines**.

Properties of Magnetic Field Lines

- They emerge from the **North pole** and enter the **South pole** (outside the magnet)
 - Inside the magnet, they go from South to North (forming closed loops)
 - They never cross each other
 - Closer lines = stronger field; farther apart = weaker field
 - They are closed continuous curves
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2. Magnetic Field Due to Current-Carrying Conductor

Hans Christian Oersted (1820) discovered that a current-carrying conductor produces a magnetic field around it. This is the link between electricity and magnetism.

a) Magnetic Field Around a Straight Conductor

The magnetic field lines around a straight current-carrying wire are **concentric circles** centered on the wire.

Right-Hand Thumb Rule: Grip the wire with your right hand so that the thumb points in the direction of current flow. Your curled fingers show the direction of the magnetic field.

- The field is stronger near the wire and weaker farther away
- Increasing the current makes the field stronger

b) Magnetic Field Due to a Circular Loop (Coil)

When current flows through a circular loop, the field lines inside the loop are nearly straight and parallel — creating a pattern similar to a bar magnet.

- One face of the loop acts as North pole, the other as South pole
- More turns in the coil → stronger magnetic field
- More current → stronger magnetic field

c) Magnetic Field Due to a Solenoid

A **solenoid** is a coil of many turns of insulated wire wrapped in a cylindrical shape. When current flows through it, it produces a uniform magnetic field inside — just like a bar magnet.

- One end becomes North pole, the other becomes South pole
- The field inside the solenoid is strong and uniform (parallel lines)
- The field outside is weak and non-uniform

Electromagnet: A solenoid with a soft iron core inside it. The iron core gets magnetised and greatly increases the magnetic field strength. Electromagnets can be turned on/off by switching the current.

Uses of electromagnets: Cranes for lifting heavy iron/steel, electric bells, MRI machines, speakers, magnetic locks.

3. Force on a Current-Carrying Conductor in a Magnetic Field

When a current-carrying conductor is placed in a magnetic field, it experiences a **force**. This force is maximum when the conductor is **perpendicular** to the magnetic field and zero when it is **parallel**.

Fleming's Left-Hand Rule (Motor Rule)

Stretch the thumb, forefinger, and middle finger of your **left hand** at right angles to each other:

- **Forefinger:** Direction of the magnetic field (B) — North to South
- **Middle finger:** Direction of the current (I)
- **Thumb:** Direction of the force/motion on the conductor

Memory aid: FBI — Forefinger = B (field), Middle finger = I (current), Thumb = Force (motion)

4. Electric Motor

An **electric motor** converts **electrical energy into mechanical energy** (rotational motion). It works on the principle that a current-carrying conductor in a magnetic field experiences a force (Fleming's Left-Hand Rule).

Construction

- **Armature (coil ABCD):** Rectangular coil of insulated copper wire mounted on a shaft that can rotate
- **Permanent magnets (N and S):** Provide the magnetic field
- **Split ring commutator:** Two half-rings connected to the ends of the coil; reverses the direction of current every half rotation
- **Brushes:** Carbon or graphite contacts that connect the rotating commutator to the external battery

Working

1. Current flows through the coil → the two arms of the coil experience forces in opposite directions (Fleming's LHR)
2. This creates a torque that rotates the coil
3. After half a rotation, the commutator reverses the current direction in the coil
4. This ensures the force continues to push the coil in the same direction of rotation
5. The coil keeps spinning continuously

Role of commutator: Without it, the coil would rotate half a turn and then stop (forces would balance). The commutator reverses the current every half turn to keep the rotation going.

Uses: Electric fans, washing machines, mixers, drills, electric vehicles.

5. Electromagnetic Induction

Michael Faraday (1831) discovered that a changing magnetic field around a conductor induces an electric current in it. This is called **electromagnetic induction**.

Ways to induce current:

- Move a magnet towards or away from a coil
- Move a coil towards or away from a magnet
- Change the current in a nearby coil (changing the magnetic field)

Key points:

- The induced current exists only as long as the magnetic field is **changing**
- If the magnet is stationary (no change), no current is induced
- The direction of induced current reverses when the direction of motion reverses
- Faster motion or more turns in the coil → greater induced current

Fleming's Right-Hand Rule (Generator Rule)

Stretch the thumb, forefinger, and middle finger of your **right hand** at right angles:

- **Forefinger:** Direction of magnetic field (B)

- **Thumb:** Direction of motion of the conductor
 - **Middle finger:** Direction of the induced current (I)
-

6. Electric Generator

An **electric generator** converts **mechanical energy into electrical energy**. It works on the principle of electromagnetic induction.

Construction (similar to a motor)

- Rectangular coil (armature) that rotates in a magnetic field
- Permanent magnets or electromagnets
- Slip rings (for AC generator) or split ring commutator (for DC generator)
- Carbon brushes

Working

1. The coil is rotated mechanically (by turbine, wind, water, etc.) in a magnetic field
2. As the coil rotates, the magnetic flux through it changes continuously
3. This changing flux induces an EMF (and current) in the coil — electromagnetic induction
4. The current is collected by brushes via slip rings

AC vs DC Generator

Feature	AC Generator	DC Generator
Current type	Alternating current (changes direction)	Direct current (flows in one direction)
Uses	Slip rings (2 complete rings)	Split ring commutator
Used in	Power stations, household electricity	Batteries, charging, small devices

In India: AC is used at **220 V, 50 Hz** (the current changes direction 50 times per second).

7. Domestic Electric Circuits

How Electricity Reaches Our Homes

1. Power station generates electricity at 11,000–33,000 V (AC)
2. Step-up transformer increases voltage for long-distance transmission (reduces energy loss)
3. Transmitted at very high voltage via power lines

4. Step-down transformers near homes reduce voltage to **220 V**

5. Two wires enter the house: **Live wire** (red, at 220 V) and **Neutral wire** (black, at 0 V)

Components of a Domestic Circuit

Component	Function
Live wire (L)	Red/brown insulation; carries current at 220 V
Neutral wire (N)	Black/blue insulation; at approximately 0 V; completes the circuit
Earth wire (E)	Green insulation; connected to a metal plate buried in the ground; safety measure — carries leaked current to earth
Main fuse	Connected to the live wire; breaks circuit if current exceeds safe limit
Electric meter	Measures total energy consumed (in kWh/units)
MCB (Miniature Circuit Breaker)	Modern replacement for fuse; automatically trips when current is too high; can be reset

Important Safety Points

- All appliances are connected in **parallel** between the live and neutral wires
 - Each appliance gets the same voltage (220 V) and can be switched independently
 - The earth wire is connected to the metal body of appliances — if a live wire touches the metal body, current flows to the earth instead of through the person → prevents electric shock
 - **Short circuit:** When live and neutral wires come in direct contact (insulation damaged) → very large current flows → overheating → fire risk. The fuse/MCB protects against this.
 - **Overloading:** When too many appliances are connected to a single circuit → total current exceeds the safe limit → overheating. Avoid using too many appliances on one circuit.
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Important Definitions

Term	Definition
Magnetic field	Region around a magnet where its magnetic force can be experienced
Solenoid	Cylindrical coil of many turns of insulated wire that produces a magnetic field like a bar magnet when current flows
Electromagnet	Solenoid with a soft iron core; produces a strong, controllable magnetic field
Fleming's Left-Hand Rule	Gives the direction of force on a current-carrying conductor in a magnetic field (motor rule)
Electric motor	Device that converts electrical energy to mechanical (rotational) energy
Electromagnetic induction	Generation of electric current by changing the magnetic field around a conductor
Fleming's Right-Hand Rule	Gives the direction of induced current in a conductor moving in a magnetic field (generator rule)
Electric generator	Device that converts mechanical energy to electrical energy
Commutator	Split ring device that reverses current direction every half rotation in a motor/DC generator
Short circuit	Direct contact between live and neutral wires causing very large current flow
Overloading	Drawing more current from a circuit than it is designed to handle

Solved Examples (NCERT-Based)

Example 1

Why does a compass needle get deflected when brought near a current-carrying wire?

Answer: A current-carrying wire produces a magnetic field around it (Oersted's discovery). A compass needle is a small magnet that aligns itself along the magnetic field. When the compass is near the wire, it experiences the magnetic field of the wire and gets deflected from its normal north-south direction. The greater the current, the greater the deflection.

Example 2

What is the function of the split ring in an electric motor?

Answer: The split ring acts as a **commutator**. It reverses the direction of current flowing through the coil every half rotation. Without this reversal, the coil would rotate only half a turn and then stop. The commutator ensures the force on

the coil arms continues to push in the same rotational direction, keeping the motor spinning continuously.

Example 3

State the difference between an AC generator and a DC generator.

Answer: The key difference is in the output and the type of rings used:

- An **AC generator** uses **slip rings** (two complete rings) and produces alternating current that reverses direction periodically.
- A **DC generator** uses a **split ring commutator** that reverses the connection every half cycle, producing direct current that flows in only one direction.

Both work on the same principle (electromagnetic induction) and have similar construction otherwise.

Example 4

Why is the earth wire connected to metallic appliances?

Answer: The earth wire provides a low-resistance path for electric current to flow to the ground. If due to a fault, the live wire touches the metal body of an appliance, a large current flows through the earth wire to the ground instead of through the person who touches the appliance. This immediately blows the fuse or trips the MCB, cutting off the supply. Without the earth wire, the person would receive a severe electric shock.

Important Questions for Board Exams

1-Mark Questions

1. State Fleming's Left-Hand Rule.
2. What is the function of a commutator in an electric motor?
3. What is the frequency of AC supply in India?
4. Name the device that converts mechanical energy to electrical energy.
5. What is a short circuit?

2-Mark Questions

1. What is the difference between Fleming's Left-Hand Rule and Right-Hand Rule?
2. Why does a current-carrying conductor placed in a magnetic field experience a force?
3. What is the role of the earth wire in domestic circuits?
4. How is an electromagnet different from a permanent magnet?
5. What is electromagnetic induction? Who discovered it?

3-Mark Questions

1. Draw a labelled diagram of an electric motor. Explain its working principle.
2. Draw the magnetic field pattern around a current-carrying solenoid. How is it similar to a bar magnet?
3. What is the difference between AC and DC? Name the device used to generate each.
4. Explain the working of an AC generator with a labelled diagram.
5. What are the causes of short circuit and overloading? How does a fuse protect a circuit?

5-Mark Questions

1. Explain the construction and working of an electric motor with a labelled diagram. What is the role of the split ring commutator?
 2. What is electromagnetic induction? Describe the construction and working of an AC generator. How is it different from a DC generator?
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Quick Revision Points

- Oersted: current-carrying conductor produces magnetic field
 - Magnetic field around straight wire: concentric circles (Right-Hand Thumb Rule for direction)
 - Solenoid: coil producing uniform field inside (like bar magnet)
 - Electromagnet: solenoid + soft iron core → strong, switchable magnet
 - Force on current-carrying conductor in magnetic field → Fleming's Left-Hand Rule (F-B-I)
 - Electric motor: electrical → mechanical energy; uses commutator to reverse current every half turn
 - Electromagnetic induction (Faraday): changing magnetic field → induced current
 - Fleming's Right-Hand Rule → direction of induced current (generator)
 - AC generator: slip rings → alternating current; DC generator: split ring commutator → direct current
 - India: 220 V, 50 Hz AC
 - Domestic circuit: Live (220 V) + Neutral (0 V) + Earth (safety)
 - Appliances connected in parallel: same voltage, independent operation
 - Safety devices: Fuse (melts), MCB (trips) — protect against short circuit and overloading
 - Earth wire: prevents electric shock by providing a low-resistance path to ground
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Previous Chapter: Chapter 11 — Electricity

Next Chapter: Chapter 13 — Our Environment



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