# 🟦 Chapter 12: Magnetic Effects of Electric Current

## 🔷 Introduction

Electric current doesn't just produce heat — it also creates magnetic effects. When current passes through a conductor, it produces a magnetic field around it. This chapter explains:

- Magnetic fields and field lines
- Magnetic effects of current
- Right-hand and left-hand rules
- Magnetic field from coils and solenoids
- Force on current-carrying conductors
- Domestic electric circuits

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## 🔹 12.1 Magnetic Field and Field Lines

**🟦 Magnetic Field:**
The region around a magnet where its magnetic force can be felt.

**🟦 Magnetic Field Lines:**
Imaginary lines that represent the direction and strength of magnetic fields.

- They emerge from the north pole and enter the south pole.
- They are denser where the magnetic field is stronger.
- Magnetic field lines never intersect.

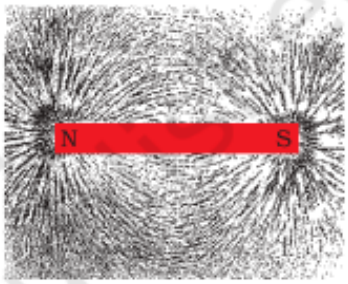


***Figure 12.2***
*Iron filings near the bar magnet align themselves along the field lines.*

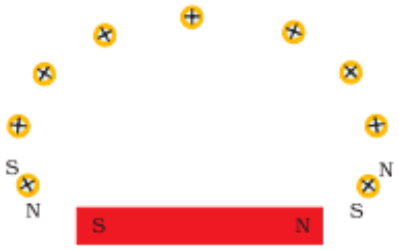


***Figure 12.3***
*Drawing a magnetic field line with the help of a compass needle*

## 🧪 Activity 12.2:

Sprinkle iron filings around a bar magnet. Tap the board gently. The filings align along field lines, showing magnetic field patterns.

## 🧪 Activity 12.3:

Use a compass to draw field lines of a bar magnet by tracing how the needle points from north to south.

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## 🔹 12.2 Magnetic Field due to Current-Carrying Conductor

### 🧪 Activity 12.1:

Place a compass near a current-carrying straight wire. The needle deflects, showing magnetic field is produced.

### 🟦 Conclusion:

Electric current produces a magnetic field.

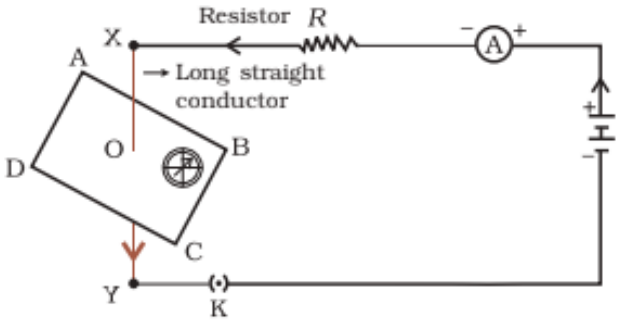


***Figure 12.1***
*Compass needle is deflected on passing an electric current through a metallic conductor*

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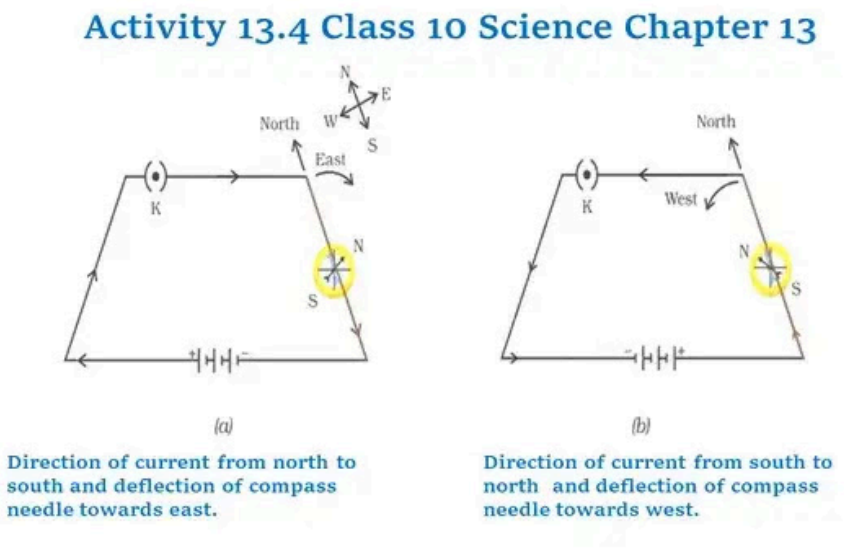
## 🔸 12.2.1 Magnetic Field from Straight Wire

### 🧪 Activity 12.4 & 12.5:

Connect a long straight wire in circuit over a compass. Observe deflection when current flows. Reverse the current to reverse the deflection.




### 🧠 Key Observations:

- Magnetic field is stronger when current increases.
- Magnetic field is weaker when distance from wire increases.

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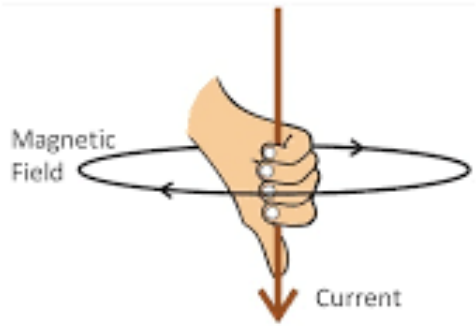
## 🔸 12.2.2 Right-Hand Thumb Rule

🟦 Right-Hand Thumb Rule:
Hold a straight conductor in your right hand with thumb in the direction of current. Fingers curl in the direction of magnetic field.

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## 🔸 12.2.3 Magnetic Field from Circular Loop

🟦 **Circular Loop:**
When a wire is bent into a circle and current flows, magnetic field forms concentric circles at every point. At the center, field lines appear straight and strong.

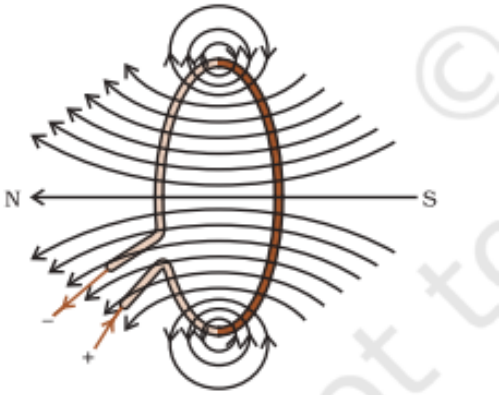


***Figure 12.8***
*Magnetic field lines of the field produced by a current-carrying circular loop*

### 🟦 Multiple Turns:

Field strength increases with number of turns in coil.

#### 🧪 Activity 12.6:

Pass current through circular coil. Iron filings show strong field at center.

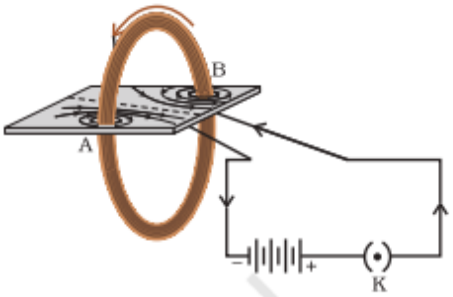


***Figure 12.9***
*Magnetic field produced by a current-carrying circular coil.*

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## 🔸 12.2.4 Magnetic Field from Solenoid

### 🟦 Solenoid:

A coil of many turns of wire in cylindrical shape.

- Field inside is uniform and strong (like bar magnet).
- One end acts as north pole, the other as south.

### 🟦 Electromagnet:

A solenoid with soft iron core becomes a temporary magnet.

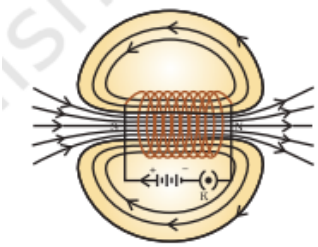

**Figure 12.10**
*Field lines of the magnetic field through and around a current carrying solenoid.*

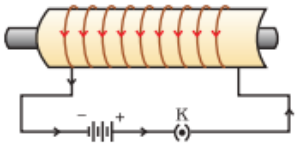


**Figure 12.11**
*A current-carrying solenoid coil is used to magnetise steel rod inside it – an electromagnet.*

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## 🔹 12.3 Force on a Current-Carrying Conductor in a Magnetic Field

### 🟦 Magnetic Force:

A current-carrying conductor experiences a force when placed in a magnetic field.

### 🧪 Activity 12.7:

Place aluminium rod between magnetic poles and pass current. Rod moves, indicating a magnetic force is acting.

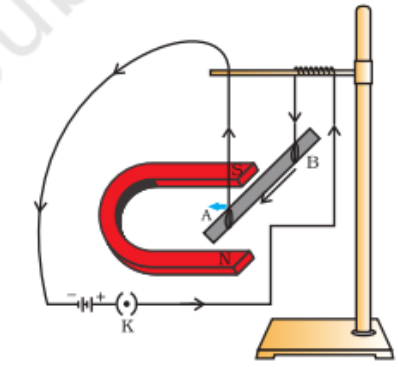


**Figure 12.12**
*A current-carrying rod, AB, experiences a force perpendicular to its length and the magnetic field. Support for the magnet is not shown here, for simplicity.*

### 🟦 Fleming's Left-Hand Rule:

Stretch thumb, forefinger, and middle finger of left hand at right angles.

- Forefinger → Magnetic field
- Middle finger → Current
- Thumb → Force (motion)

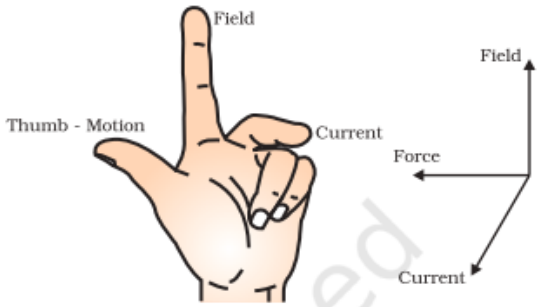


**Figure 12.13**
*Fleming's left-hand rule*

Example:
Direction of force on an electron moving perpendicular to a magnetic field is determined using this rule.

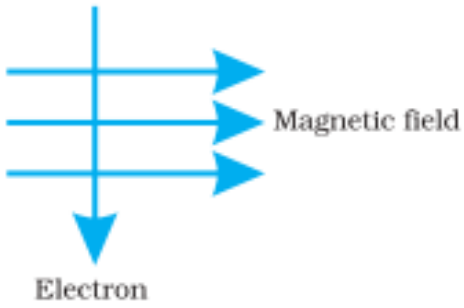


**Figure 12.14**

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## 🔹 12.4 Domestic Electric Circuits

### 🟦 Components:

- Live wire (Red) – carries current
- Neutral wire (Black) – returns current
- Earth wire (Green) – for safety

### 🟦 Supply:

AC power supply of 220 V and 50 Hz in India

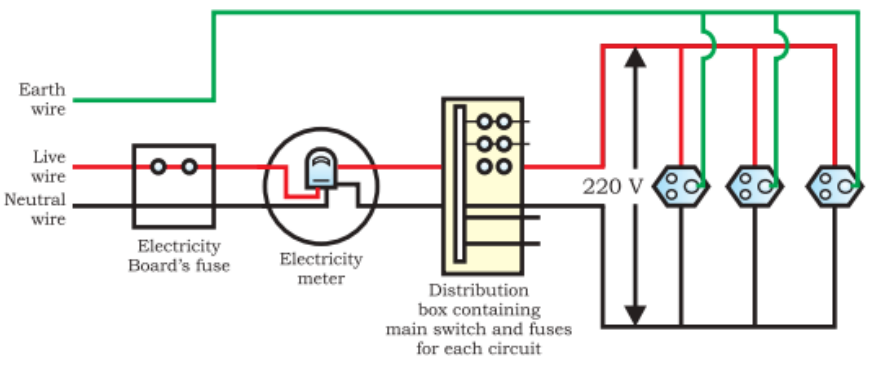


**Figure 12.15** *A schematic diagram of one of the common domestic circuits*

### 🧠 Two circuits at home:

- 15 A – for heavy appliances (geyser, heater)
- 5 A – for low power items (fan, bulb)

### 🟦 Earthing:

Connects metal body to ground → prevents electric shock from leakage.

### 🟦 Electric Fuse:

A safety device that melts if current is too high, breaking the circuit.

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## ✅ Summary

- Electric current produces magnetic field (Oersted's experiment)
- Magnetic field lines are visualized using iron filings and compass
- Right-hand thumb rule shows direction of field around a conductor
- Circular loops and solenoids enhance field strength
- Fleming's left-hand rule determines force on conductor in magnetic field
- Electromagnets are used in electric motors and medical MRI machines
- Domestic wiring includes live, neutral, and earth wires
- Fuses prevent damage from short circuits and overloading