10
Chapter

Electric Current and its Effects

We'll cover the following key points:

- Electric Circuits & Circuit Diagram
- Magnetic Effect of Current

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Learning Outcomes

By the end of this chapter, students will be able to:

- Students will understand the concept of electric current and its flow in a circuit.
- They will be able to read and draw simple circuit diagrams using symbols for electrical components.
- Students will learn how electric current produces magnetic effects and how electromagnets are created.
- They will explore the practical applications of electromagnets in devices such as electric bells and motors.

Guidelines for Teachers

To introduce the chapter, the teacher can ask students about how electronic devices like doorbells, fans, and motors work. Visual aids, such as simple circuit diagrams, can be used to explain the concept of electric circuits. Demonstrating the magnetic effect of current using a simple experiment (e.g., wrapping a wire around an iron nail to create an electromagnet) will help students relate to the topic practically.

For teaching the working of an electric bell, a live demonstration or an animated video can provide a clear understanding of the mechanism. Discussions about real-life applications of electromagnets, such as in cranes or medical equipment, can make the lesson engaging and relatable.

NCF Curricular Goals and Competencies

This chapter addresses the following curricular goals and competencies:

- **CG-7 (C-7.1):** Students communicate their own questions, observations, and conclusions related to science.

Mind Map

ELECTRIC CURRENT AND ITS EFFECTS

Symbols of electric components

S. no.	Electric component	Symbol
1.	Electric cell	
2.	Electric bulb	
3.	Switch in 'ON' position	
4.	Switch in 'OFF' position	
5.	Battery	
6.	Wire	

Heating effect of electric current

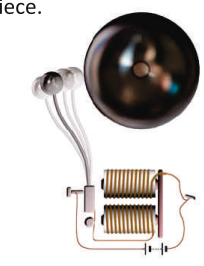
- **Electric heater :** Contains a coil of wire called **element**.
- **Electric bulb**: The filament of electric bulb gets heated to such a high temperature that it starts glowing.
- **Incandescent electric bulb**
  - ✓Fluorescent Tube Lights
  - ✓Compact Fluorescent Lamps (CFL)
  - ✓Light Emitting Diode (LED)
- **Electric fuse** : Wires made up of special material that melt quickly and break when high electric current passed through it.
- Miniature Circuit Breakers (MCB)
  - ✓They are used in place of fuses
  - ✓These are switches which automatically turn off when current in a circuit exceeds the safe limit.

Magnetic effect of electric current

- Hans Christian Oersted was the first person who noticed the deflection of compass needle every time the current was passed through the wire.
- It means, electric wire behaves like magnet. That is the magnetic effect of current.

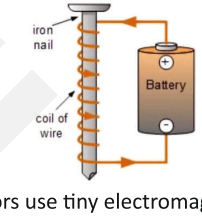
Electric bell

Consists of a coil of wire wound on an iron piece.



Electromagnet

When electric current is switched off, the coil losses its magnetism

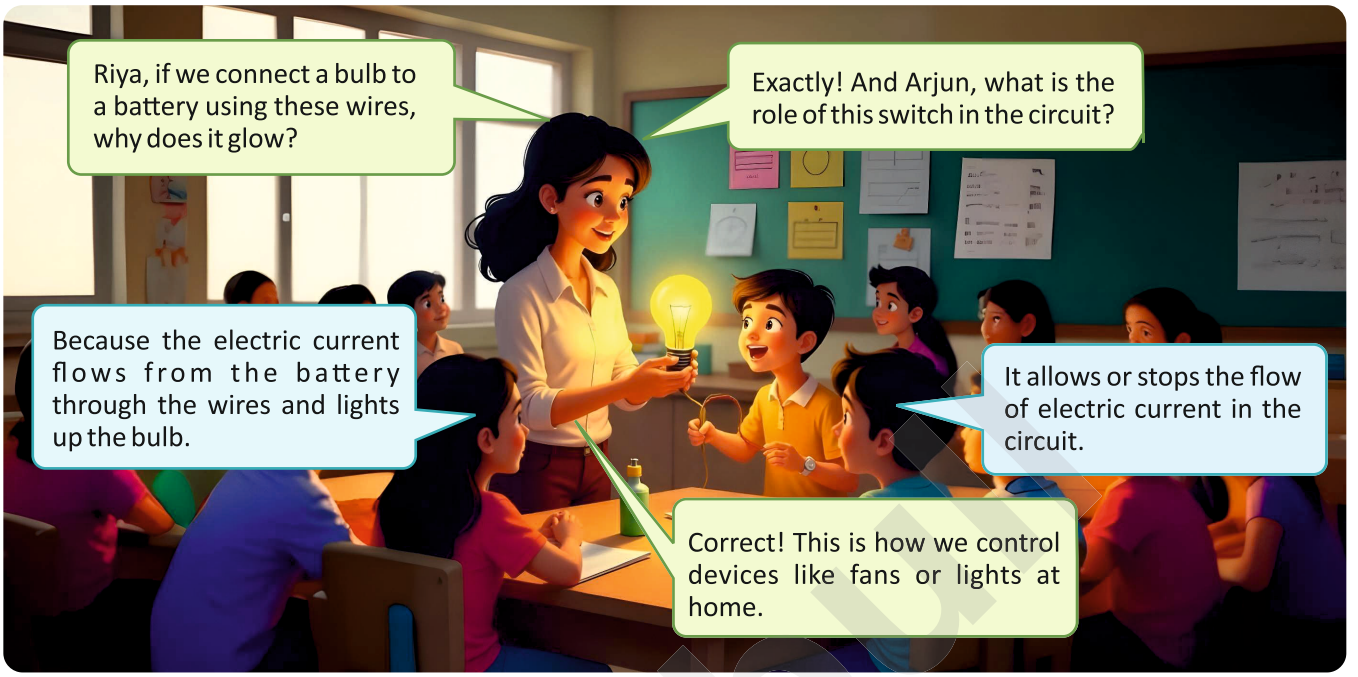


Doctors use tiny electromagnets to take out small pieces of magnetic material that have accidentally fallen in the eye. Many toys also have electromagnets inside them.

Based on NCERT*

Electric Circuits & Circuit Diagram

The teacher is holding a battery, a bulb, wires, and a switch.



Most of the electrical equipments at our homes run on electric current. The lighting of an electric bulb is the most common example of effect of electric current. The simplest source of an electric current is an electric cell. The current starts from the positive terminal of the cell, passes through the equipment connected to it, and terminates at the negative terminal of the cell.

In History...

- **Hans Christian Orsted:** Discovered the relationship between electricity and magnetism, leading to electromagnetism.
- **Michael Faraday:** Demonstrated the principles of electromagnetic induction, foundational for electric motors and transformers.
- **Thomas Edison:** Developed practical applications of electric current, including electric lighting systems.
- **Nikola Tesla:** Pioneered alternating current (AC) systems and the induction motor.
- **William Sturgeon:** Invented the electromagnet and explored its uses in technology.

KEYWORDS

AC is the standard form of electricity supplied to homes and industries, characterized by its frequency (e.g., 50 Hz or 60 Hz) and voltage level.

Applications: Widely used for powering appliances, transmission of electricity over long distances, and in devices like transformers and electric motors.

Electric Circuits

A cell (or battery) is a source of electric current. Electric current can flow between the two terminals of the cell through conducting materials when all are well connected. Any closed path along which electric current or current carrying charge carriers can flow, is called an electric circuit.

An electric circuit generally consists of the following components :

- A source of electric current (cell or battery)
- A conducting wire (say copper wire)
- An electrical appliance (like bulb)
- A switch/key

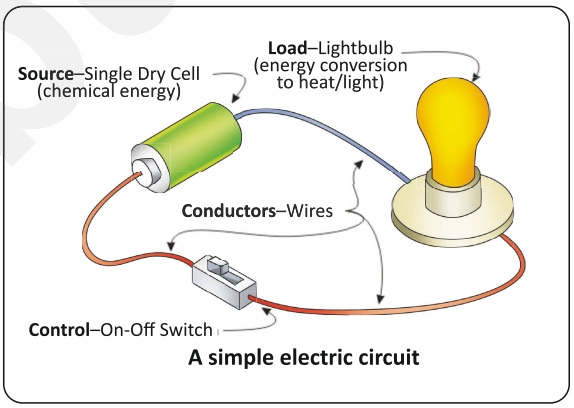
An electric circuit provides a complete path for electric current to flow continuously between the two terminals (positive and negative) of a source of energy (electric cell or battery) through some electrical devices lying in the same path.

Usually in practice, a gap is provided in the path by an electric switch that can be opened or closed to either cut off or allow the current flow.

The given figure represents a simple electric circuit of a flashlight using a dry cell as a source of energy, a switch and a light bulb.

When the switch is closed, the circuit is complete and the electric current starts flowing through the light bulb and it glows. In this process, actually the electrical energy stored in the dry cell is transformed into the light energy.

We will discuss all of these in detail.



A simple electric circuit

Battery

Battery is a device which generates current by a chemical reaction. You must be using batteries in toys, torches and remote controls. The basic unit of a battery is a cell. A cell usually contains a metal container filled with chemicals and a carbon rod. It has a positive and a negative terminal.

When both these terminals are joined to a device through wires, the cell generates current to make the device work. Sometimes one cell is not enough to run a device like a remote or a toy. In this case two or more cells can be joined together to form a series of cells.

In a series, the positive terminal of one cell is joined to the negative terminal of the next cell. This series of cells is called a battery.

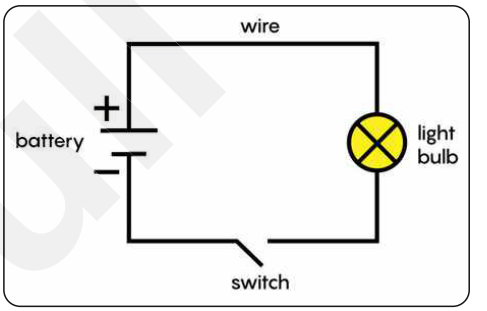
Switch

A switch is used to open and close a circuit. Switch is also called a key. When a switch is 'ON', it connects the two open ends of the circuit. The circuit flows into it. When the switch 'OFF', the two ends of the circuit are open, and the current does not flow through it. We use electric switches to run all devices at home.

A circuit is always connected to an appliance that works with current. For example, the filament of a bulb gets heated up by current and glows. A fan's blades rotate when current passes through it.

Conducting wires: Conducting wires are used to connect different components of a circuit. These are generally copper wires with an insulated covering. Copper is a very good conductor of current and hence is used for this purpose.

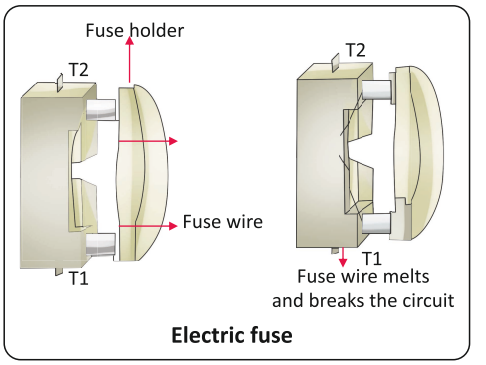
Circuit Diagram



A circuit diagram is a figure which represents all components of a circuit and the connections between them. In a circuit diagram different components are shown by symbols which are easy to draw.

You know that all solids are made up of particles. These particles, called atoms, vibrate at their position. When current flows through a solid, the vibrations of atoms resist its passage. This produces heat. Metals like copper, silver and aluminium do not resist the conductors. These metals do not heat up much on passing current. However metals and **alloys** like tungsten and nichrome offer high substances, they heat up quickly. Many devices, such as geyser, kettles, hair dryer, electric iron, oven, etc. work on this principle. In passes through it, a lot of heat is generated. The filament starts glowing and produces lot of heat. The heat generated by a device depends upon the thickness and length of the **filament** used in it.

A very important use of heating effect is in electric fuse. An electric fuse is a safety device connected in every domestic and commercial circuit. It contains a wire made up of an alloy which has low point. If due to some reason, there is sudden over-flow of current in the circuit, the fuse wire heats up and melts, breaking the circuit. This prevents damage to the appliances connected to the circuit and prevents a fire due to short circuit.



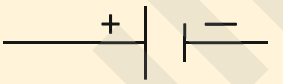
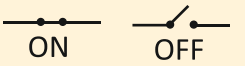
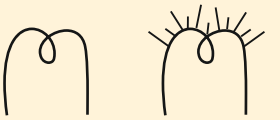
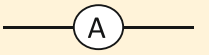
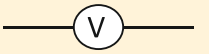
Electric fuse

KEYWORDS

Alloys: Alloys are materials made by combining two or more elements, usually metals, to enhance their properties, such as strength, corrosion resistance, or conductivity.

Filament: A filament is a slender thread-like structure, commonly used in 3D printing, light bulbs, or as part of materials that require fine and durable strands.

These days, household and commercial circuits are connected miniature circuit breaker (MCB). It has a series of switches to different circuits in the house. MCB allows only a certain of current to pass through the circuit. If the current exceeds this limit, the supply is cut off.

Components	Symbol
Cell	 The longer line represents positive terminal and shorter line represents negative terminal.
Battery	
Key on, key off	
Wire	
Bulb	
Ammeter	
Volt meter	

Activity

Do this activity under your teacher's supervision. Take a piece of nichrome wire and put it on a table. Connect it to a battery and switch, with wires. Keep the switch open. Touch the wire. Now close the switch and let current pass through wire for 30s. Open the switch and again touch the wire. What do you feel? You will observe that the wire is hot. Note down your observations in your notebook.

Let's recall what we know

SCAN TO ACCESS

Take a Task

Watch Remedial

Apply Concept in Context

Apply

- How would the circuit behave if the switch is left open? Explain with a diagram.
- If a bulb does not glow even when connected to a battery, what could be the possible reasons?

Skills Covered: Critical thinking, Applicative thinking, Brainstorming

Examine Further

Analyse

What will happen if the wires in a circuit are damaged or broken? Explain the impact on the circuit's functionality.

Skills Covered: Critical thinking, Analytical thinking, Brainstorming, Research, Investigation

Self-Assessment Questions

Evaluate

- What is an electric circuit, and how is it represented diagrammatically?
- Why is it important to use symbols while drawing a circuit diagram?
- What are the functions of a battery, switch, and bulb in a circuit?

Skills Covered: Research, Observation, Recall

Creative Insight

Create

Electric circuits are essential for the functioning of most devices in our daily lives. Circuit diagrams use standard symbols to represent components like wires, batteries, and bulbs, making it easy to design and troubleshoot circuits.

Task: Draw a circuit diagram showing a battery, switch, bulb, and resistor. Indicate the direction of current flow and label each component.

Skills Covered: Research, Creativity, Observation, Brainstorming

Bloom's Taxonomy

Magnetic Effect of Current

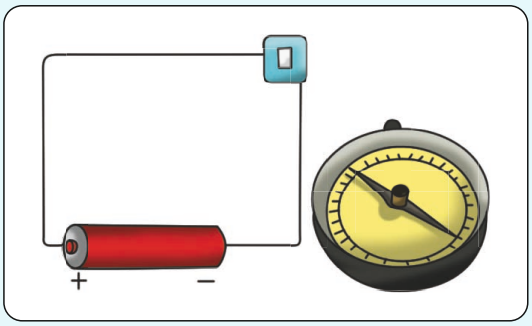
The teacher is demonstrating a wire wound around an iron nail connected to a battery.

In 1820, a Danish physicist Hans Christian Oersted was performing some experiments with electricity. He observed that when current passed through a wire, the needle of the magnetic compass that was kept close by showed a deflection. Hence, when electric current passes through a wire, it behaves like a magnet. This came to be known as the magnetic effect of electric current. You can demonstrate this effect by performing the given activity.

Activity

Aim: To show the magnetic effect of current

Materials required: Connecting wires, a magnetic compass, a cell and a switch



Method:

- Make a circuit as shown using the connecting wires, the switch and the cell.
- Place the magnetic compass near the wire.
- Put the switch in the ON position to let the current flow through the circuit. Observe the needle of the magnetic compass.
- Now, stop the current by putting the switch in the OFF position.
- Repeat this three to four times.

Observation: Every time current passes through the wire, the needle of the magnetic compass shows deflection.

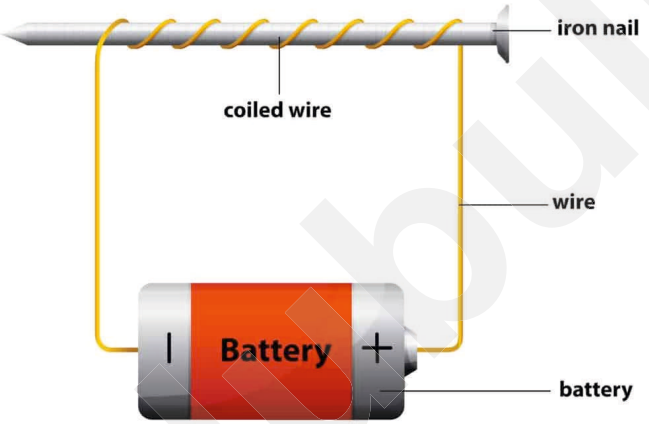
Conclusion: Current flowing through a wire has a magnetic effect associated with it.

Electromagnets

From the activity given above, you must have learnt that electric current has a magnetic effect associated with it. This property of electric current is used to change magnetic materials like soft iron into magnets by passing electricity through them. Such magnets are called electromagnets. In the activity given below, we will learn how to make an electromagnet.

You will observe in the activity given above that every time the switch is in the ON position and the current is flowing, the paper pins get attracted to the nail. When the switch is in the OFF position, the pins fall off. This shows that an electromagnet works only when the current is flowing through it.

The strength of the electromagnets depend on the number of turns of the wire used around the core and the amount of current passing through it.

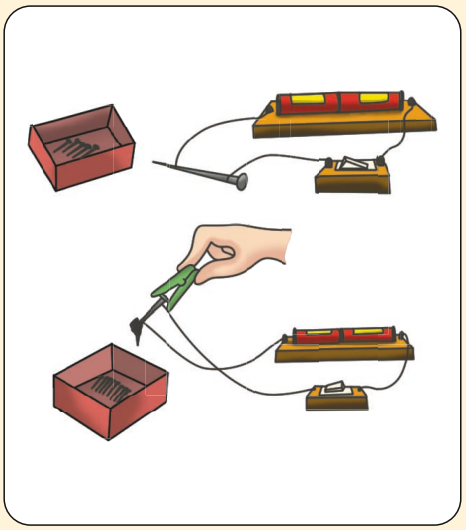


Activity

Aim: To make an electromagnet (Note: Activity to be performed under adult supervision)

Materials required: A long insulated wire, a big nail, a few paper pins, a switch, a battery and a plastic clip

Method:

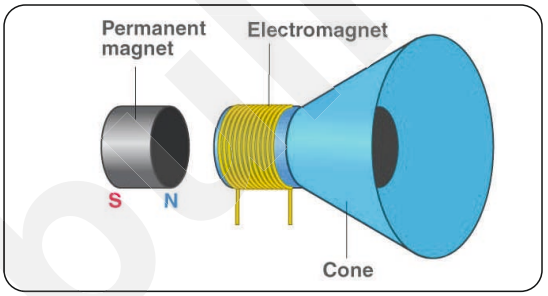


- Take a wire and wind it around a nail as shown.
- Connect the open ends of the wire to the battery through a switch to complete the circuit.
- Now put the switch in ON position.
- Hold the nail with a plastic clip carefully and move it near the paper pins. You will see that the paper pins cling on to the iron nail.
- Put the switch in OFF position. The paper pins will fall off.
- Repeat the activity three to four times. The electromagnet is ready.

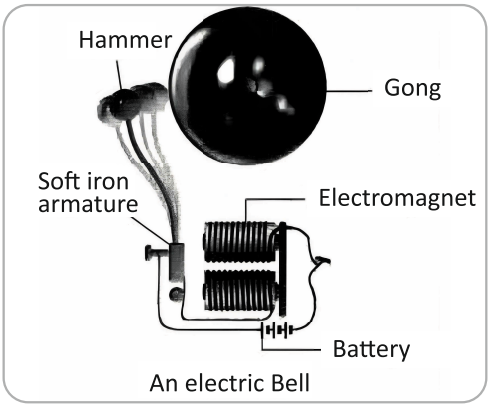
USES OF ELCTROMAGNETS

Some of the important uses of electromagnets are given below.

- Electromagnets are used in motors that drive fans, mixers, washing machines, etc.
- Cranes with strong electromagnets are used to lift heavy loads like big machines, steel girders and scrap iron objects for loading and unloading purposes.
- Electromagnets are used to separate magnetic materials like iron and steel objects from a heap of junk metal scrap.
- Electromagnets are used by doctors to remove tiny iron particles from the eyes of a person (which may have fallen into the eyes accidentally).
- Electromagnet are also be used in electric bells, telegraphs, telephone instruments, loud speakers, etc.



Working of Electric Bell



An electric Bell

An electric bell contains a circuit with a switch, battery, and electromagnet, a soft iron armature connected to a spring, a gong and a hammer.

It works in the following ways:

- When the current flows through the circuit, the electromagnet creates a magnetic field which attracts the soft iron armature.
- As the armature moves towards the electromagnet, the hammer hits the gong and sound is produced. The circuit breaks.
- The current stops flowing and the magnetic field of the electromagnet is lost. So the armature moves back and connects to the circuit again.
- This cycle continues and causes repeated hitting of the hammer on the gong, producing continuous sound.

KEYWORDS

Magnetic Field: A region around a magnetic material or moving electric charge where magnetic forces can be observed.

Soft Iron Armature: A component made of soft iron, often used in electrical devices, to efficiently concentrate and guide the magnetic field.

Let's recall what we know

Apply Concept in Context

Apply

- How are electromagnets used in industries? Provide examples.
- If the current in an electromagnet is increased, how would it affect its strength?

Skills Covered: Critical thinking, Applicative thinking, Brainstorming

Examine Further

Analyse

What will happen if the iron core of an electromagnet is replaced with a plastic core? Analyze its effect on the magnetism.

Skills Covered: Critical thinking, Analytical thinking, Research

Self-Assessment Questions

Evaluate

- What is the magnetic effect of current?
- How does an electromagnet differ from a permanent magnet?
- Explain the working of an electric bell.
- List two advantages of using electromagnets over permanent magnets.

Skills Covered: Research, Observation, Recall

Creative Insight

Create

Electromagnets demonstrate how electric current produces magnetism. They are essential in devices like electric bells and cranes, showcasing their versatility in lifting heavy objects or producing sound.

Task: Build a simple electromagnet using a nail, wire, and a battery. Record your observations and explain how changing the number of coils affects the magnet's strength.

Skills Covered: Creativity, Research, Observation, Brainstorming

Bloom's Taxonomy

SCAN TO ACCESS

Take a Task

Watch Remedial

SUMMARY

Electric Circuits & Circuit Diagrams

Electric Circuits: A closed path through which electric current flows, consisting of a power source, wires, and devices like bulbs or switches.

Components:

- **Battery/Cell:** Provides energy for the circuit
- **Bulb:** Lights up when current flows.
- **Switch:** Controls the current flow (ON/OFF).
- **Wires:** Provide a path for current to flow.

Examples: A glowing bulb when the switch is ON.

A working torch with a complete circuit.

Circuit Diagrams : A visual representation of an electric circuit using standard symbols for components.

- **Symbols:** Cell, Battery, Bulb, Switch (Open/Closed).
- **Importance:** Simplifies understanding, design, and troubleshooting of circuits.

Electric Fuse: A safety device that stops excess current to prevent damage.

- **Key Features:** Made of a thin wire that melts when current is too high, breaking the circuit. Prevents overheating or fires.
- **Example:** Used in old plug systems and electrical appliances.

Miniature Circuit Breakers (MCBs) : A modern device that cuts off power automatically when current is excessive.

- **Key Features:** Can be reset after tripping. More reliable and durable than fuses.
- **Usage:** Found in homes and industries to protect circuits.

Magnetic Effect of Electric Current

1. Magnetic Effect of Electric Current: Electric current flowing through a wire produces a magnetic field around it (discovered by Orsted).

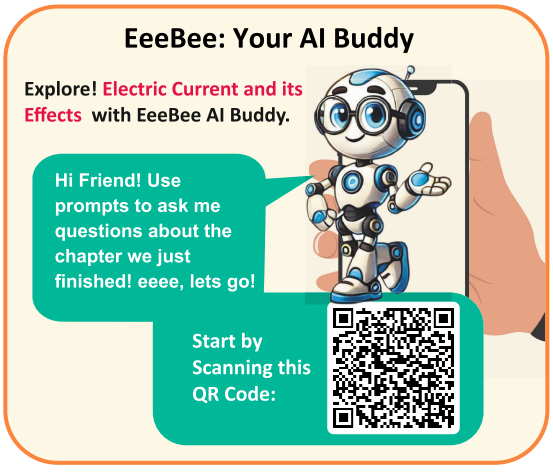
- **Key Feature :** Attracts objects made of iron, nickel, or cobalt.

2. Electromagnets : A magnet created by passing electric current through a wire coil around an iron core.

- **Key Features:** Works only when current flows. Can be strengthened by increasing the number of coils or current.
- **Uses:** Lifting heavy metal objects in scrapyards. Electric bells and bank door locks.

3. Working of an Electric Bell: Uses an electromagnet to produce sound.

- **Working:** Current flows, creating a magnetic field. The magnet pulls a hammer to strike the bell. The circuit breaks, stopping the current. The process repeats, causing continuous ringing.



Gap Analyzer™
Take a Test

EXERCISE

That turn curiosity into confidence—let's begin!

A. Choose the correct answer.

1. What is needed for a bulb to glow in a circuit?
   (a) An open circuit ☐ (b) A closed circuit ☐
   (c) Only a switch ☐ (d) None of the above ☐
2. Which of the following is not a component of a circuit?
   (a) Battery ☐ (b) Wire ☐
   (c) Magnet ☐ (d) Bulb ☐
3. What is the main purpose of a fuse in an electric circuit?
   (a) To light up the circuit ☐ (b) To control the flow of current ☐
   (c) To prevent excess current ☐ (d) To act as a switch ☐
4. An electric bell uses which of the following?
   (a) Permanent magnet ☐ (b) Electromagnet ☐
   (c) Solar cell ☐ (d) Capacitor ☐
5. What happens to the fuse when excessive current flows through it?
   (a) It lights up ☐ (b) It melts ☐
   (c) It increases the current flow ☐ (d) It makes a noise ☐

B. Fill in the blanks.

1. An electric circuit must be _____ for current to flow.
2. A _____ is a device that melts to stop the flow of excessive current in a circuit.
3. A _____ can be reset after turning off the current during a fault.
4. An electric bell works on the principle of _____.
5. A _____ produces electricity and powers a circuit.

C. Write True or False.

1. An electric circuit needs a power source to work.
2. A switch is used to increase the flow of current in a circuit.
3. Electromagnets are temporary magnets created by electric current.
4. Fuses and MCBs help protect electrical appliances from damage.
5. An electric bell does not use an electromagnet to produce sound.

D. Define the following terms.

1. Electric Circuit
2. Circuit Diagram
3. Electromagnet
4. Electric Fuse
5. MCB

E. Match the columns.

Column A	Column B
1. Electric Circuit	(a) Uses a coil and current to work
2. Fuse	(b) Prevents excess current flow
3. MCB	(c) Automatically turns off power
4. Electromagnet	(d) Complete path for current
5. Electric Bell	(e) Produces sound using a magnet

F. Give reasons for the following statements.

1. An electric circuit must be closed for the bulb to glow.
2. Fuses are important in electrical systems.
3. MCBs are more convenient than traditional fuses.
4. Electromagnets are widely used in devices like electric bells.
5. A circuit diagram helps to easily understand how a circuit works.

G. Answer in brief.

1. What are the main components of an electric circuit?
2. What is the purpose of a switch in a circuit?
3. How does a fuse protect electrical appliances?
4. What is the role of an electromagnet in an electric bell?
5. Why are MCBs preferred over traditional fuses?

H. Answer in detail.

1. Explain the working of an electric bell with the help of a diagram.
2. Describe the importance of a fuse in an electric circuit and how it works.
3. What are MCBs, and how do they enhance safety in electrical circuits?
4. Explain the steps involved in creating an electromagnet and its uses.
5. Compare the uses of fuses and MCBs in protecting electrical appliances.

NEP Corner

Know about NEP 2020

Goodbye, Single Language Studies!

NEP 2020 promotes multilingual education. Learn in your mother tongue, but also master global languages like English and French.

Skill-based Activity

Explore Electric Current and its Effects

STEM

Perform the given activity at your home to understand the concepts of electric circuits and the magnetic effect of current.

You will need a battery, copper wire, a small light bulb, and a switch (use under adult supervision).

- Connect the battery, light bulb, and switch to form a simple circuit. Ensure the circuit is complete, and the switch is in the "off" position.
- Close the switch to turn the light on, demonstrating the flow of electric current.
- Observe the components and identify how the electric current flows through the circuit.
- Compare this to how current affects the operation of an electromagnet.

Now, answer the following questions:

- What is an electric circuit, and why is it important for the flow of current?
- How does the working of an electric bell demonstrate the magnetic effect of current?
- What is the role of a fuse in an electrical circuit?

Skills Covered: Observation, Analytical thinking, Logical thinking, Brainstorming

Electric Circuit

Art

Create a 3D model of an electric circuit using craft materials:

- Use materials like wires, a battery, and a small bulb to represent the components of a basic electric circuit.
- Include elements like a switch, fuse, and battery to show how the circuit functions safely.
- Label each part clearly and write a description of its function in your notebook.

Skills Covered: Creativity, Analytical thinking, Organization, Brainstorming

Electric Current and Magnetic Effect

Group Activity

Students can collect materials like nails, copper wire, and batteries to experiment with creating electromagnets. They will classify the materials based on their ability to conduct electricity and generate magnetic fields.

1. Test different materials to see which can become a stronger magnet.
2. Experiment with the electric bell to understand how current generates movement.

Skills Covered: Critical thinking, Logical thinking, Brainstorming, Collaboration, Social skills, Networking

Factors Influencing Electric Current

Case to Investigate

Investigate how the following factors affect the behavior of electric circuits. Collect data through observations or experiments and present it as a report.

Factors	Data Collected
Size and material of conductor	
Voltage applied	
Presence of a fuse or switch	
Effect of magnetic fields on current flow	

Compile your findings and present them in a report.

Skills Covered: Critical and analytical thinking, Research, Brainstorming, Investigation, Communication

Sustainable Electrical Practices

Aligning with SDGs

Discuss how modern techniques such as fuse protection, circuit breakers, and efficient electrical wiring help in the safe and sustainable use of electric current. Reflect on how these practices prevent electrical hazards and enhance safety.

Aligned with SDG 7: Affordable and Clean Energy

Skills Covered: Global awareness, Critical thinking, Research, Analytical thinking, Problem-based thinking

Personalized Circuit Design

Integrated Learning

Using your knowledge of electric circuits and the magnetic effect of current, create a personalized design for a safe and efficient electrical setup for a small project or home. Consider factors like fuse protection, switch placements, and the need for efficient use of energy.

Skills Covered: Applicative thinking, Critical thinking, Research, Brainstorming, Empathy, Emotional intelligence