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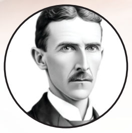


"Electricity is all around us, powering our homes, our world, and our imagination." – Nikola Tesla

Electricity: Circuits and their Components

The Big Question

Imagine a world plunged into darkness every evening, where your favorite cartoons vanish from the screen, and the comforting hum of the refrigerator falls silent. What invisible power lights up our world, runs our gadgets, and makes our lives so much easier? This chapter will unravel the mysteries of this everyday magic – electricity!

Meet EeeBee.AI

Hello, bright electricians-in-training! I'm EeeBee, your AI buddy. Let's explore circuits—power, conductors, loads—and how series and parallel wiring change electricity's flow!

Still curious? Talk to me by scanning the QR code.

Learning Outcomes

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

- Identify and describe the common uses of electricity in daily life.
- Explain what a battery is and how cells are combined to form one.
- Construct a simple electric circuit and illustrate the path of electric current.
- Analyze simple circuit arrangements to predict if a lamp will glow.

Science Around you

Electricity is the silent workhorse of modern society. From charging your mobile phone and lighting your home to powering hospitals, industries, and transportation like metro trains, its applications are endless. Understanding electricity helps us use it safely and efficiently, and even innovate new technologies for a sustainable future.

NCF Curricular Goals and Competencies

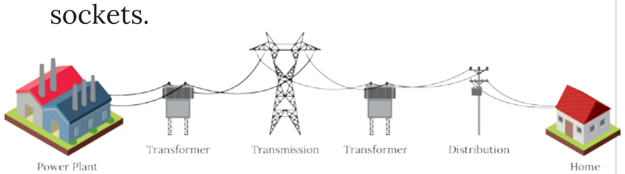
Competency Goal (CG 3.7): Understands and explains the functioning of simple electric circuits, including the roles of components such as cells, wires, bulbs, and switches. **Competency Goal (CG 3.8):** Applies knowledge of circuits to design basic models and solve practical problems related to lighting, connectivity, and troubleshooting.

Mind Map

Electricity – Circuits and their Components

Electricity in Our World

- **Its Nature, Sources, and How It Travels**
- Energy from charged particles.
- **Uses:** Homes, transport, industries, healthcare.
- **Sources:** Thermal, Hydro, Wind, Solar, Cells & Batteries.
- **Distribution:** Power grid.
- **Materials:**
  - ✓ **Conductors:** copper, aluminum, graphite, human body.
  - ✓ **Insulators:** plastic, rubber, glass, dry wood.
- **Safety:** Use cells/batteries, never wall sockets.

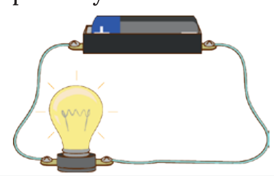


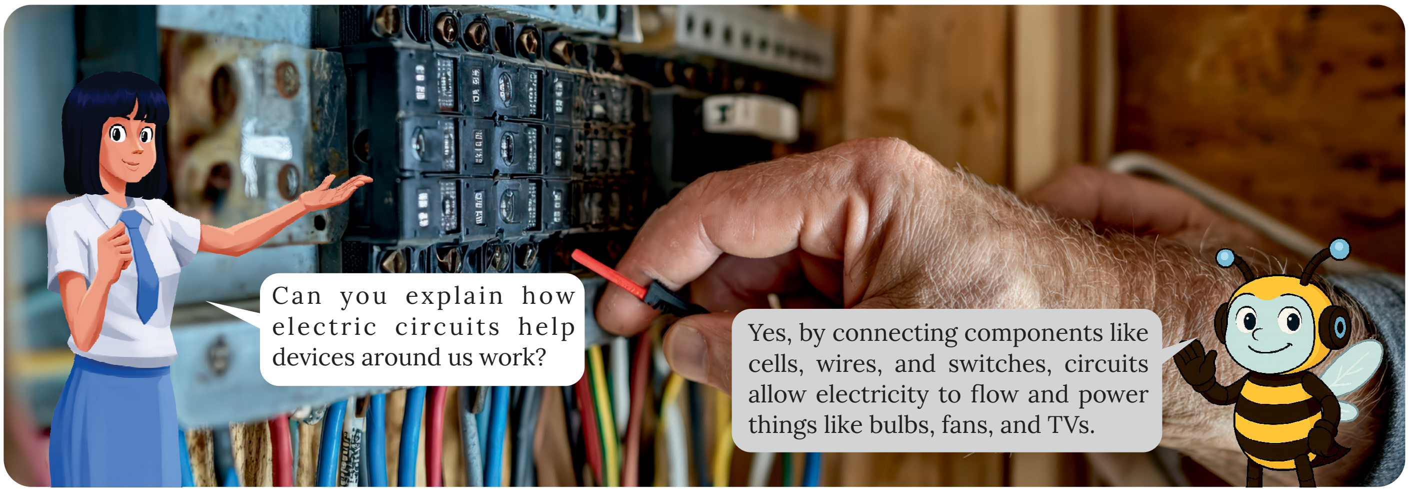
Harnessing Electrical Energy

- **Cells, Batteries, and Lighting Technologies**
- **Electric Cell:** Produces electricity from chemicals.
  - ✓ terminal = metal cap, – terminal = flat base.
- **Battery:** Two or more cells joined together for higher voltage.
- **Incandescent Lamp:** Filament glows when heated; breaks → fused bulb.
- **LED (Light Emitting Diode):** Energy-efficient light source.
  - ✓ **Anode (+):** longer lead
  - ✓ **Cathode (–):** shorter lead
  - ✓ **Current flows from** + → – for it to glow.

Controlling the Flow

- **Electric Circuits, Switches, and Schematic Diagrams**
- **Electric Circuit:** Closed loop needed for current to flow. (ek circuit diagram laga dena)
  - ✓ **Closed circuit:** current flows (lamp ON).
  - ✓ **Open circuit:** no flow (lamp OFF).
- **Switch:** Controls current by opening/closing circuit.
- **Circuit Diagrams:** Use symbols to represent parts:
  - ✓ Cell, Battery, Lamp, LED, Switch, Wire.
- **Polarity:** Correct connections are vital, especially for LEDs.





In Focus

- Electricity in Our World
- Harnessing Electrical Energy
- Controlling the Flow

Introduction

Electricity is the invisible force that powers our modern world, from the lights in our homes to the devices in our pockets. This chapter delves into the fascinating realm of electricity, specifically exploring how it flows and is controlled. We will uncover the fundamental principles behind electric circuits, understanding how various components work together to direct and utilize this powerful energy source. By the end, you'll have a clear grasp of how electricity safely and efficiently powers our daily lives.

From History's Pages

Our understanding of electricity evolved over centuries. Around 600 BC, Ancient Greeks observed static electricity with amber. In 1752, Benjamin Franklin's kite experiment proved lightning is electrical and proposed positive/negative charges. Alessandro Volta invented the first battery in 1800, providing steady electric current for experiments. Michael Faraday's early 19th-century work on electromagnetism paved the way for motors and generators. Later, Thomas Edison developed the first practical incandescent light bulb, transforming daily life. These pioneers, among many others, unlocked the secrets of electricity, leading to the technologies we rely on today.

Electricity in Our World

Electricity is a versatile form of energy resulting from charged particles, like electrons. It can be easily converted into light, heat, sound, and mechanical energy, making it indispensable in our daily lives.

Uses of Electricity

Electricity powers almost every aspect of modern life:

In Our Homes

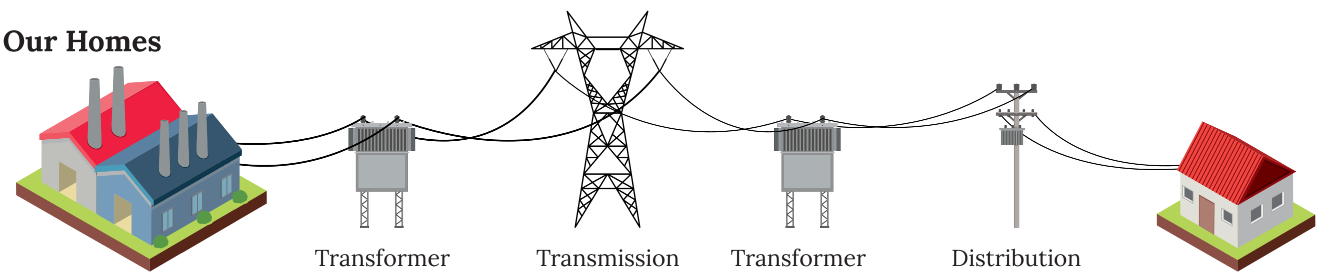


Fig. 3.1 Electricity in Our World

Electricity in Our Homes

Cooking
Electric kettles, mixer grinders, ovens, microwaves.

Entertainment
Televisions, radios, computers, gaming consoles.

Communication
Mobile phones, computers, internet modems.

Lighting
Light bulbs and tube lights illuminate our homes.

Heating and Cooling
Fans, room heaters, geysers, refrigerators, air conditioners.

Beyond Homes (Industrial and General):

Transportation
Electric trains, metro systems, electric cars, and scooters.

Industries
Powers machinery in factories, water pumps for agriculture, cranes in construction.

Healthcare
Medical equipment like X-ray machines and ventilators.

Public Spaces
Streetlights, lights in markets, schools, and offices.

Sources of Electricity

Electricity isn't just magically there; it needs to be generated.

Large-Scale Generation (Power Grid)

Thermal Power Plants

Burn **fossil fuels** (coal, natural gas) or use nuclear reactions to produce steam, which turns turbines connected to generators.

Fig. 3.2 Thermal power plants

Hydroelectric Power Plants

Use the force of falling or flowing water to turn turbines.

Fig. 3.3 Hydroelectric Power Plants

Windmills

Convert wind energy into electricity using large turbines.

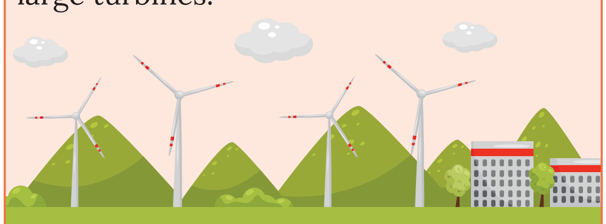


Fig. 3.4 Windmills

Solar Panels

Convert sunlight directly into electricity using photovoltaic cells. This electricity reaches us through a vast network called the power grid.

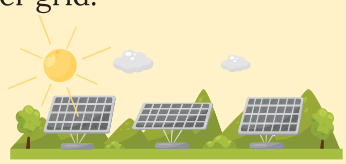


Fig. 3.5 Solar Panels

Portable Sources: For many devices, especially portable ones, we use self-contained sources:

- **Electric Cells and Batteries:** Common in torchlights, remote controls, toys, mobile phones. They convert chemical energy into electrical energy.

Fig. 3.6 Electric Cells and Batteries

How Electricity Travels

Conductors and Insulators Not all materials allow electric current to pass through them.

Conductors of Electricity

- Materials through which electric current can flow easily are called electrical conductors.
- Why they conduct: Metals (copper, silver, aluminum, iron), graphite, salt solutions, and the human body are good conductors because they have "**free electrons**" that can move easily.

  Examples: Copper and aluminum are used for wires.

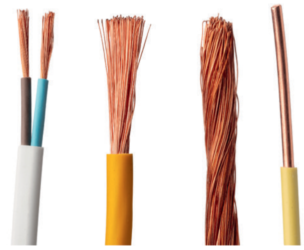


Fig. 3.7 Wire

Insulators of Electricity (Poor Conductors)

- Materials through which electric current cannot flow easily (or at all) are called electrical insulators.
- Why they don't conduct: In insulators, electrons are tightly bound to their atoms and cannot move freely.

  Examples: Plastic, rubber, glass, dry wood, air, paper, **porcelain**, pure water.

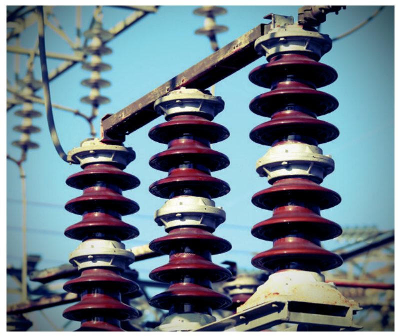


Fig. 3.8 Porcelain Insulator

Importance of Conductors and Insulators

- **Conductors:** Used to make paths for current where needed (wires, filaments).
- **Insulators:** Used to prevent current from flowing where it's not wanted, ensuring safety and preventing short circuits (e.g., plastic covering on wires, casing of switches).

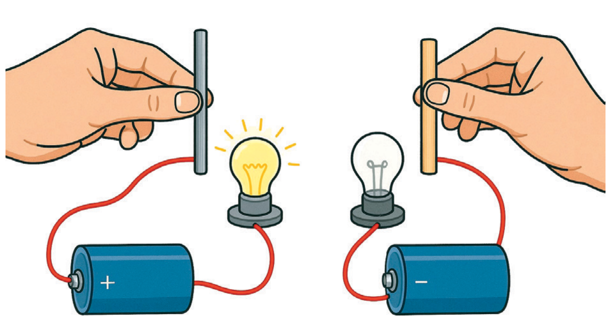


Fig. 3.9 Conductor and Insulator

Fact Flash

An average lightning bolt can release enough energy to power a 100-watt light bulb for about three months! Also, glass is an excellent insulator at room temperature, but if heated until molten, it becomes a conductor!

Caution: Electricity Can Be Dangerous!

- Never experiment with the main power supply from wall sockets.
- Pay attention to danger signs on electric poles and appliances.

Keywords

Free Electrons: Free electrons are electrons that are loosely bound to atoms and can move freely, allowing the flow of electricity in conductors.
Porcelain: Porcelain is a hard, non-conductive ceramic material often used as an insulator in electrical systems.

- For experiments, ONLY use electric cells or batteries (low voltage).
- Never touch electrical switches or appliances with wet hands. Water increases conductivity.
- Damaged wires or plugs should be repaired by a qualified electrician. Our body is a conductor of electricity. Touching a live wire can cause a dangerous electric shock. Insulating materials protect us.

Fig. 3.10 Caution

Common Misconceptions

× **Misconception:** Electricity is only used for big appliances.

✓ **Correction:** Even small devices like watches and remote controls use electricity, often from batteries.

× **Misconception:** Electricity is "made" in the wall socket.

✓ **Correction:** The socket is an outlet point. Electricity is generated in power plants and transported to our homes.

Science Around You

Electricity is a powerful force that travels at nearly the speed of light—about 300,000 kilometers per second—making it possible to power homes and cities almost instantly. In fact, a single lightning bolt can carry up to 1 billion volts of electricity, which is enough to power around 200,000 homes, though just for a brief moment. Today, energy-efficient technologies like LED bulbs, which use up to 80% less power and last 25 times longer than traditional bulbs, continue to transform how we use electricity in our daily lives.

Activity

Conductor or Insulator? The Material Test

- **Objective:** To test different materials and classify them as conductors or insulators.
- **Materials Required:** A 1.5V cell, a small torch bulb (1.5V) in a holder, three connecting wires with stripped ends, various objects to test

Fig. 3.11 Materials Required

- **Procedure:**
  1. **Tester Setup:** Connect the cell to the bulb holder with two wires, leaving a gap between the free end of one wire from the cell and one free end of a wire from the bulb. These two free ends are your tester probes.
  2. **Test the Tester:** Briefly touch the two free ends together. The bulb should light up.
  3. **Testing Materials:** Touch the two free ends of the tester to an object (e.g., metal spoon). If the bulb glows, the object is a conductor. If it doesn't, it's an insulator.
  4. Record your observations in a table.
- **Observation:**

  Note which materials allowed the bulb to glow and which did not.

Knowledge Checkpoint

Gap Analyzer™ Homework

Watch Remedial

Multiple Choice Questions:

Remembering

1. Which of these is a portable source of electricity?

a) Windmill ☐ b) Solar panel on a roof ☐

c) AA battery ☐ d) Hydroelectric dam ☐

Understanding

2. The plastic covering on electric wires acts as:

a) A conductor ☐ b) An insulator ☐

c) A filament ☐ d) A source of electricity ☐

3. Which of the following is NOT a primary use of electricity in homes?

a) Running a refrigerator ☐ b) Photosynthesis by house plants ☐

c) Lighting a room ☐ d) Charging a mobile phone ☐

Short Answer Question:

4. List two large-scale methods of generating electricity and two safety precautions when using electricity.

Applying

5. Define electrical conductors and insulators, giving two examples of each. Why is the human body considered a conductor?

Long Answer Question:

Evaluate

6. Explain why electricity is so widely used in modern society. Describe three different ways electricity is generated and discuss the importance of both conductors and insulators in an electrical appliance like a table fan.

Harnessing Electrical Energy

Portable electrical energy is vital for many devices we use daily. This energy often comes from electric cells, which can be combined to form batteries. These, in turn, power various components, including those that light up our world, like incandescent lamps and LEDs.

The Electric Cell

A Source of Portable Energy An electric cell is a device that converts chemical energy stored within it into electrical energy. It's a fundamental portable source of electricity.

Fig. 3.12 An Electric Cell

Observing an Electric Cell

- **Two Terminals:** An electric cell has two distinct ends called terminals, where wires connect to draw electricity.
- **Positive Terminal (+ve):** Usually marked with a (+) sign, often a small, protruding metal cap on one end.
- **Negative Terminal (-ve):** Usually marked with a (-) sign, typically the flat metal disc at the base.

How it Works (Simplified)

Chemical reactions inside the cell cause a buildup of positive charges at the positive terminal and negative charges (electrons) at the negative terminal. When a conducting path connects these terminals through a device (like a bulb), electrons flow from the negative to the positive terminal, creating an electric current that powers the device.

The Battery

Combining Cells for More Power Often, a single cell doesn't provide enough energy or last long enough. In such cases, we use a battery, which is typically a combination of two or more electric cells connected together.

Connecting Cells to Form a Battery (Series Connection)

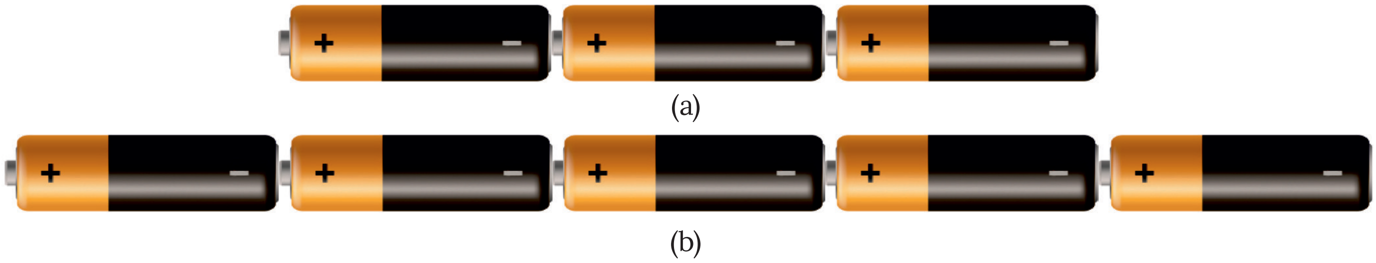


Fig. 3.13 A Battery made up of (a) 3 Cells (b) 5 Cells

- **The most common way is series connection:** the positive terminal of one cell is connected to the negative terminal of the next cell.
- **Effect:** Voltages of cells in series add up. (e.g., two 1.5V cells in series = 3V battery).
- **Incorrect Connection:** If cells are connected incorrectly (e.g., positive to positive), the battery may not work or its output will be reduced.

Battery Holders

Devices often have battery holders designed to ensure correct orientation and series connection of cells, usually with springs for negative terminals and markings (+ and -).

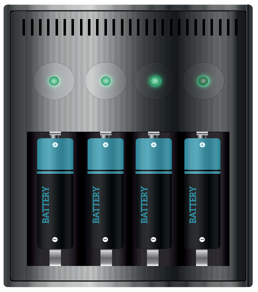


Fig. 3.14 Battery Holders

The Electric Lamp (Incandescent Lamp)

Lighting by Heating An incandescent lamp (or light bulb) produces light from electricity by heating a **filament**.

Structure:

- **Glass Bulb:** Outer glass casing, often filled with inert gas or a vacuum.
- **Filament:** A very thin, coiled wire (usually tungsten with a high melting point) that glows when hot.
- **Support Wires:** Hold the filament.
- **Terminals:** Two points to connect to a circuit:
  1. **Metal Case:** The threaded base.
  2. **Metal Tip:** At the bottom center, insulated from the case.
- **How it Glows:** Current flows through the filament, which offers resistance. This resistance causes the filament to heat up to a very high temperature, making it glow (incandesce) and emit light (and heat).
- **Fused Bulb:** If the filament breaks, the current path is interrupted, and the bulb won't glow. It's then "fused."

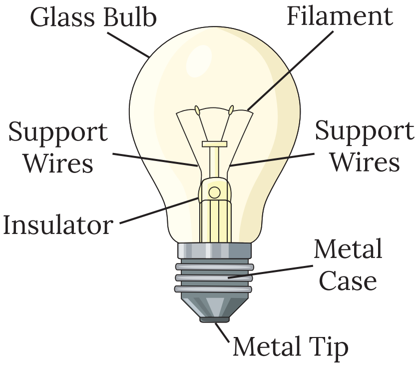


Fig. 3.15 Incandescent Lamp

Keywords

Filament: Filament is thin wire, usually made of tungsten, that glow and produce light when heated by an electric current.

The LED Lamp (Light Emitting Diode)

Efficient Lighting Light Emitting Diodes (LEDs) are modern, energy-efficient lighting components.

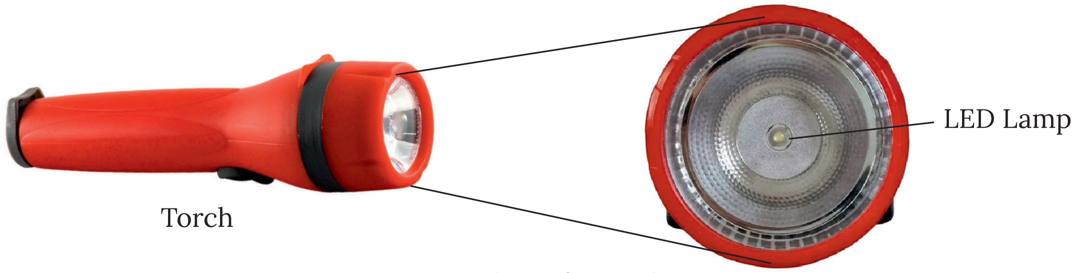


Fig. 3.16 LED lamp for torch

Fig. 3.17 LEDs of different colours

Structure:

- No Filament.
- Two Terminals (Leads):

  Positive Terminal (Anode): Slightly longer lead.

  Negative Terminal (Cathode): Shorter lead. (Sometimes casing has a flat edge on the negative side).
- **Semiconductor Chip:** Inside the plastic casing, this chip emits light when current flows correctly.

How it Works (Simplified)

LEDs work on electroluminescence. When voltage is applied correctly, electrons in the semiconductor material release energy as photons (light). The color depends on the material.

Fact Flash

The very first electric cell, Volta's "voltaic pile" (1800), used alternating copper and zinc discs separated by saltwater-soaked cardboard. The term "battery" was first coined by Benjamin Franklin for connected charged glass plates, like a "battery" of cannons. The first visible-spectrum (red) LED was developed in 1962.

Common Misconceptions

× **Misconception:** Cells "create" electrons.

✓ **Correction:** Cells do not generate electrons; they act as pumps, using chemical reactions to move existing electrons and create a flow of electricity.

× **Misconception:** The glass of an incandescent bulb glows.

✓ **Correction:** It's the thin metal filament inside that heats up and emits light; the glass merely protects it and traps the inert gas inside.

Science Around You

A standard AA battery provides 1.5 volts of electrical energy and is commonly used in household electronics. Rechargeable batteries, like lithium-ion ones, can be charged and reused hundreds of times and are found in laptops, smartphones, and electric vehicles. In lighting, incandescent bulbs convert only about 10% of energy into light, wasting the rest as heat, while LEDs convert more than 80% into light, making them far more efficient.

Activity

Battery Building and Testing Brightness

- **Objective:** To understand how connecting cells in series affects a lamp's brightness.
- **Materials Required:** Three 1.5V electric cells, cell holders (for one, two, and three cells, or use tape / wires), a small torch bulb (e.g., 2.5V or 3.8V), connecting wires.
- **Procedure:**

  Setup 1: Connect one cell to the bulb. Observe brightness.

  Setup 2: Connect two cells in series to the bulb. Observe brightness.

  Setup 3: Connect three cells in series to the bulb. Observe brightness.

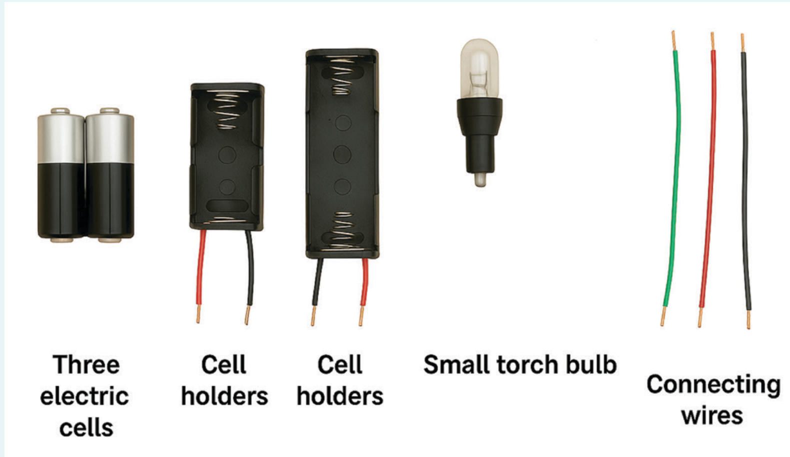


Fig. 3.18 Materials Required

- **Observation:**

  The bulb should glow brighter with more cells in series (up to its rated voltage). A reversed cell will likely cause the bulb not to glow or glow dimly.

Knowledge Checkpoint

Gap Analyzer™ Homework

Watch Remedial

Multiple Choice Questions:

Remembering

1. The positive terminal of a common dry cell is usually:

a) A flat metal disc ☐ b) A small metal cap ☐

c) The side of the cell ☐ d) Marked with a blue dot ☐

2. The part of an incandescent lamp that glows is the:

a) Glass bulb ☐ b) Metal case ☐ c) Filament ☐ d) Support wire ☐

Applying

3. To form a battery of 3V using 1.5V cells, how many cells are needed in series?

a) 1 ☐ b) 2 ☐ c) 3 ☐ d) 4 ☐

Short Answer Question:

4. Draw a diagram of two electric cells correctly connected in series to form a battery. Label the overall positive and negative terminals.

Analyzing

5. Why is the filament of an incandescent lamp usually made of tungsten? What does it mean for a bulb to be "fused"?

Evaluate

Long Answer Question:

6. Describe an electric cell and explain how it provides electricity. Then, compare and contrast an incandescent lamp with an LED in terms of their construction, working principle, and characteristics. Why are LEDs becoming more popular?

Controlling the Flow: Electric Circuits, Switches, and Schematic Diagrams

For electrical devices to work, they need a complete pathway for electric current. This pathway is an electric circuit. We can control when electricity flows in this circuit using an electric switch. To easily understand and communicate how circuits are built, we use standard symbols to draw circuit diagrams. Let's explore how these elements work together.

The Electric Circuit

An electric circuit is a continuous and unbroken (closed) path for electric current to flow from a source (like a cell or battery), through a device (like a lamp or LED), and back to the source.

Making a Lamp Glow

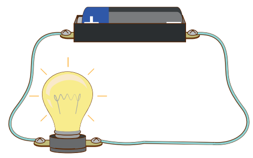


Fig. 3.19 Electric Circuit

- **Components Needed:** An electric cell (source), an electric lamp (device), and connecting wires (path).
- **A Complete Circuit:** For a lamp to glow, a complete path must be formed.
  1. One terminal of the cell must be connected to one terminal of the lamp.
  2. The other terminal of the cell must be connected to the other terminal of the lamp.
  3. Connections are made using conducting wires, with their plastic insulation removed at the ends to expose the metal conductor.

Path of Electric Current

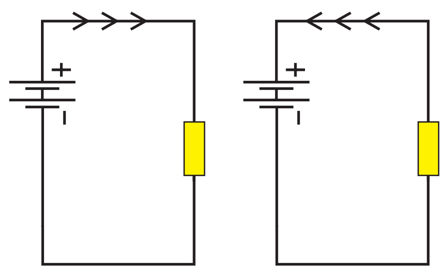


Fig. 3.20 Path of Electric Current

- **Conventional Current:** By convention, the direction of electric current in a circuit is taken to be from the positive terminal (+) of the electric cell, through the external circuit (wires and lamp), to the negative terminal (-) of the cell.
- **Electron Flow (Actual Flow):** In reality, in metal conductors, it's the negatively charged electrons that move. Electrons flow from the negative terminal (-) of the cell, through the circuit, to the positive terminal (+). However, for circuit analysis, we usually use the conventional current direction.

Open and Closed Circuits

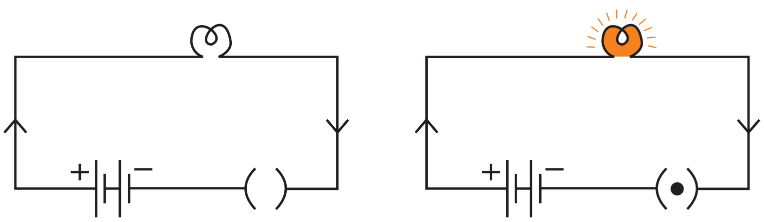


Fig. 3.21 Open and Closed Circuits

- **Closed Circuit:** When the path is complete and continuous, allowing current to flow, it is called a closed circuit. The lamp glows in a closed circuit.
- **Open Circuit (Broken Circuit):** If there is any break in the path (e.g., a loose wire, a broken filament in the lamp, or an open switch), the current cannot flow. This is called an open circuit. The lamp does not glow in an open circuit.

Keywords

Conventional current is the flow of positive charge from the positive terminal to the negative terminal of a power source.

Making an LED Glow

When using an LED in a circuit, not only must the circuit be complete, but the LED must also be connected with the correct polarity:

- The positive terminal (longer lead/anode) of the LED must be connected towards the positive terminal of the battery.

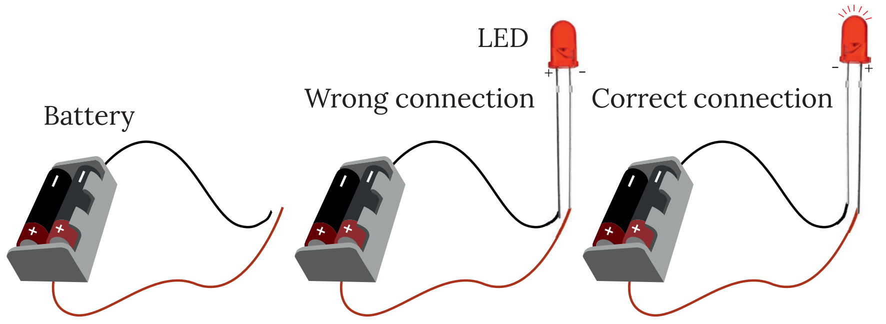


Fig. 3.22 Making an LED Glow

- The negative terminal (shorter lead/cathode) of the LED must be connected towards the negative terminal of the battery. If an LED is connected in reverse, it will block the current flow (acting like an open circuit in that direction for lighting purposes), and it will not glow, even if the path is otherwise complete.

The Electric Switch: The Circuit Controller

An electric switch is a simple device that is used to either complete (close) or break (open) an electric circuit. It allows us to conveniently control the flow of current and turn appliances ON or OFF as needed.

Making a Simple Switch: A basic switch can be made using:

- Two drawing pins
- A safety pin (or a paper clip)
- Two wires
- A small piece of cardboard or wood as a base. Construction:
- Insert one drawing pin through the looped end (ring) of the safety pin and fix it to the cardboard. The safety pin should be able to rotate freely around this drawing pin.
- Fix the second drawing pin to the cardboard a short distance away, such that the free end of the safety pin can touch it.
- Connect one wire to each drawing pin. These wires will then be connected into the main circuit.

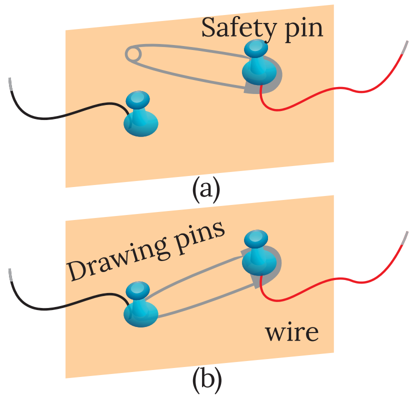


Fig. 3.23 Making a Simple Switch

How the Switch Works

- **OFF Position:** When the safety pin is not touching the second drawing pin, there is a gap in the circuit. The circuit is open, and no current flows. The lamp connected in the circuit will not glow.
- **ON Position:** When the safety pin is rotated to touch the second drawing pin, it bridges the gap. The circuit is now closed, and current can flow through the switch and the rest of the circuit. The lamp connected in the circuit will glow.

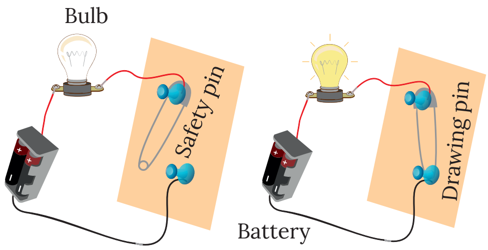


Fig. 3.24 OFF and ON Position

Function of a Switch

A switch acts as a gatekeeper for the electric current.

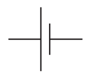
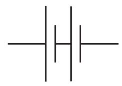
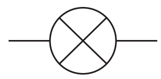
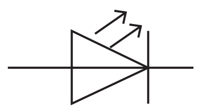
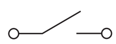
- In the **ON state**, it provides a continuous conducting path.
- In the **OFF state**, it creates an air gap (or uses an insulating material) to break the conducting path. Air is an insulator. Switches used in our homes for lights, fans, and other appliances work on the same principle, though their design and construction are more complex and robust for safety and durability. They can be placed anywhere in the circuit to control the flow of current.

> **Fact Flash**
>
> The speed of the electrical signal (the effect of current) in a wire is close to the speed of light, but the individual electrons themselves **drift** relatively slowly through the wire, like a very slow-moving crowd! Early electric switches were often large, knife-like levers.

Circuit Diagrams and Symbols: The Language of Circuits

Drawing pictures of actual electric cells, lamps, and switches every time we want to represent an electric circuit can be cumbersome and time-consuming. To simplify this, electricians and scientists use standard symbols to represent different electrical components. A diagram that uses these symbols to show how components are connected in a circuit is called a circuit diagram or a schematic diagram.

Standard Electrical Symbols

S.No.	Electrical Component	Symbol
1	*Electric Cell* 	
2	*Battery* 	
3	*Electric Lamp (Incandescent)*	
4	*Light Emitting Diode (LED)* 	
5	*Switch in 'ON' position*	
6	*Switch in 'OFF' position*	
7	*Wire* 	

Understanding the Symbols

- **Electric Cell:** The long line represents the positive (+) terminal, and the short, thicker line represents the negative (-) terminal.
- **Battery:** A combination of cell symbols. The overall positive terminal is the long line at one end, and the overall negative terminal is the short line at the other end.
- **Electric Lamp:** A circle with a cross or a filament shape inside.

Keywords

Drift refers to the slow, net movement of free electrons in a conductor when an electric field is applied.

- **LED:** A triangle (representing the diode) pointing in the direction of conventional current flow, with a line at its tip. Two arrows pointing away from it signify light emission. The base of the triangle is the anode (+), and the line is the cathode (-).
- **Switch (ON):** Shows a completed path between its terminals.
- **Switch (OFF):** Shows a broken path between its terminals.
- **Wire:** A simple straight line representing a conducting path.

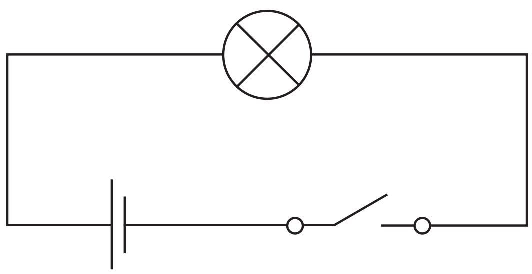
Advantages of Using Circuit Diagrams

- **Simplicity and Clarity:** Easier and quicker to draw than realistic pictures.
- **Universality:** Standard symbols are understood by people worldwide.
- **Easy Analysis:** Helps in understanding connections and troubleshooting circuits.

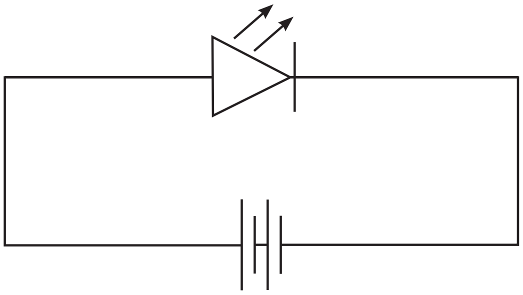
Drawing Circuit Diagrams

You can practice drawing circuit diagrams for the circuits you build. For example:

- **Circuit with switch OFF:** Would show a cell, a switch symbol in OFF position, and a lamp, all connected by lines (wires).
- **LED glowing:** Would show a battery (two cells), an LED symbol (correctly oriented), and wires.



(a) With an electric lamp



(b) With an LED lamp

Fig. 3.25 A circuit diagram (a) with an electric lamp (b) with an LED lamp

Common Misconceptions

× **Misconception:** Electricity flows out of only one terminal of the cell and gets "used up" in the lamp.

✓ **Correction:** For current to flow, there must be a complete circuit. Electricity flows through the lamp and returns to the other terminal of the cell. Energy from the cell is converted in the lamp, but the charge carriers (electrons) continue to move.

× **Misconception:** A single wire is enough to light a bulb from a cell.

✓ **Correction:** You need two connection points on the bulb and two on the cell, forming a complete loop.

Science Around You

When you flip a switch to turn on a light or press a button on your remote, you're using an electric circuit in action. Homes, schools, and electronic gadgets all rely on carefully designed circuits to control the flow of electricity. Even toys, doorbells, and kitchen appliances work because of these circuits managing the electric flow behind the scenes.

Activity

Circuit Detective

- **Objective:** To identify why a circuit might be open or incomplete.
- **Materials Required:** A cell, a bulb in a holder, connecting wires.
- **Procedure:**
  1. First, set up a simple circuit that makes the bulb glow.
  2. Now, introduce "faults" one by one and observe if the bulb glows:
     - Disconnect one wire from the cell.
     - Disconnect one wire from the bulb holder.
     - Loosen the bulb in its holder.
     - Use a wire with its insulation still on at one end for a connection.
     - (If using multiple cells) Insert one cell incorrectly in a battery holder.
- **Observation:** For each case where the bulb doesn't glow, explain why the circuit is open or incomplete. Draw diagrams for each faulty setup.

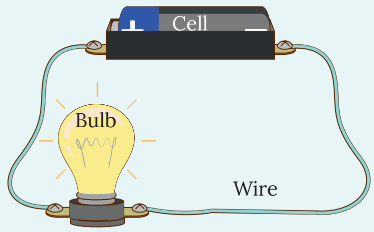


Fig. 3.26 Materials Required

Knowledge Checkpoint

Gap Analyzer™ Homework

Watch Remedial

Multiple Choice Questions:

Remembering

1. The symbol for an electric cell in a circuit diagram is:

a) A circle with a cross ☐ b) Two small circles connected by a line ☐

c) One long and one short parallel line ☐ d) A zigzag line ☐

Understanding

2. For an electric current to flow and light a lamp, the circuit must be:

a) Open ☐ b) Closed ☐

c) Made of insulators only ☐ d) Connected to only one terminal of the cell ☐

3. In a simple switch made with a safety pin and two drawing pins, what happens when the safety pin touches both drawing pins?

a) The circuit opens ☐ b) The circuit closes ☐

c) The cell gets charged ☐ d) The safety pin acts as an insulator ☐

Short Answer Question:

4. What is an electric circuit? Draw a diagram of a closed circuit showing a cell, a lamp, and connecting wires, with an arrow indicating the direction of conventional current.

5. Explain the function of an electric switch. Describe its 'ON' and 'OFF' positions in terms of the circuit.

Analyzing

Long Answer Question:

6. Explain the difference between an open circuit and a closed circuit using the example of lighting a torch bulb with an electric cell. What conditions must be met for the bulb to glow? How does this differ slightly if you are using an LED instead of an incandescent bulb? Also, explain why standard symbols are used to draw circuit diagrams.

SUMMARY

1. Electricity in Our World – Its Nature, Sources, and How It Travels

Electricity is a versatile form of energy from charged particles, easily converted into light, heat, sound, and motion. It powers homes (appliances, lights), transport (EVs), industries (machinery), and healthcare (medical devices).

It's generated from large-scale sources like:

- Thermal plants (burning fossil fuels)
- Hydroelectric plants (water force)
- Windmills (wind energy)
- Solar panels (sunlight)

Electricity reaches users via the power grid. Portable sources include electric cells and batteries, which convert chemical energy into electrical energy, used in torches, remotes, etc.

Materials are:

- Conductors (e.g., copper, aluminum, graphite, human body) – allow easy current flow
- Insulators (e.g., plastic, rubber, dry wood, glass, air) – resist current flow

Conductors and insulators are both vital for functional and safe systems.

Electrical safety: NEVER use wall socket power in experiments—only use cells/batteries (low voltage).

2. Harnessing Electrical Energy – Cells, Batteries, and Lighting Technologies

An electric cell has:

- Positive terminal (+): metal cap
- Negative terminal (−): flat metal base

A battery is two or more cells connected (usually in series) to increase voltage.

An incandescent lamp glows when its filament heats up. If the filament breaks, the bulb is "fused."

An LED emits light without a filament. It has:

- Anode (+): longer lead
- Cathode (−): shorter lead

Current must flow from anode to cathode for it to light up. LEDs are energy-efficient and long-lasting.

3. Controlling the Flow – Electric Circuits, Switches, and Schematic Diagrams

An electric circuit is a closed loop for current.

- Closed circuit: current flows (lamp ON)
- Open circuit: no current (lamp OFF)

Switches control current by opening/closing the circuit.

Circuit diagrams use symbols to show component connections:

- Cell, Battery, Lamp, LED, Switch (ON/OFF), Wire

Correct polarity is essential, especially for LEDs.

Example Based Questions

Multiple Choice Questions

1. Which of the following is a good conductor of electricity?

(a) Wood (b) Plastic

(c) Copper (d) Rubber

Answer: (c) Copper

Explanation: Copper is a metal and an excellent conductor of electricity. That is why electrical wires are made of copper, while wood, plastic, and rubber are insulators used for safety.

2. Which energy resource is commonly used in hydroelectric power plants?

(a) Wind energy

(b) Flowing water

(c) Sunlight

(d) Coal

Answer: (b) Flowing water

Explanation: Hydroelectric plants use the force of moving water to rotate turbines that generate electricity. This is a renewable and eco-friendly source of energy.

3. Which device is used to open or close an electric circuit?

(a) Battery

(b) Bulb

(c) Switch

(d) Wire

Answer: (c) Switch

Explanation: A switch controls the flow of current. When the switch is "ON," the circuit is complete and current flows; when "OFF," the circuit is broken and electricity stops.

Short Answer Questions

4. Why are electrical wires covered with plastic?

Answer: Plastic is an insulator that does not allow current to pass through it. Covering wires with plastic prevents electric shocks and makes handling safe. Thus, while the copper wire carries current, the plastic coating ensures safety.

5. Give two examples of renewable and non-renewable sources of energy used for generating electricity.

Answer:

- **Renewable sources:** Solar energy, Wind energy.
- **Non-renewable sources:** Coal, Petroleum.

Renewable sources can be replenished naturally and are eco-friendly, while non-renewable ones are limited and cause pollution.

6. What happens if the circuit in a torch is broken?

Answer: If the circuit is broken, the flow of electricity stops. As a result, the bulb will not glow. This shows that electricity flows only in a closed circuit.

Long Answer Questions

8. How is electrical energy generated and harnessed for our daily use? Explain with examples.

Answer:

Electricity is produced using various energy sources:

1. **Hydroelectric Power:** Flowing water rotates turbines to generate electricity. Example: Bhakra Nangal Dam in India.
2. **Thermal Power:** Coal is burned to produce steam that drives turbines.
3. **Solar Power:** Sunlight is captured by solar panels to produce electricity. Example: Solar lamps in rural areas.
4. **Wind Power:** Windmills convert wind energy into electrical energy.

Harnessing Electricity:

The electricity generated is transmitted through power lines and reaches homes, schools, and industries. It is then used to run fans, computers, refrigerators, machines, etc.

Conclusion: Harnessing electricity has transformed human life by providing comfort, progress, and innovation, but using renewable sources ensures sustainability and less pollution.

Gap Analyzer™
Complete Chapter Test

EXERCISE

A. Choose the correct answer.

1. The metal cap on an electric cell represents its:
   (a) Negative terminal (b) Positive terminal
   (c) Neutral point (d) Insulator
2. What is the thin wire inside an incandescent lamp that glows to produce light called?
   (a) Conductor (b) Insulator
   (c) Filament (d) Switch
3. An electrical circuit is defined as:
   (a) Electricity source (b) Electricity-consuming device
   (c) Complete current path (d) Electricity-conducting material
4. When a switch is in the 'OFF' position, the circuit is:
   (a) Closed (b) Open
   (c) Shorted (d) Complete
5. Why are the handles of electricians' tools like screwdrivers and pliers usually covered with plastic or rubber?
   (a) Attractive appearance (b) Better grip
   (c) Protect from shocks (d) Make tools lighter

B. Fill in the blanks.

1. The force of falling water is used to generate electricity in a ____________ power house.
2. An electric cell has two ____________ , a positive and a negative.
3. The flat metal disc on an electric cell is its ____________ terminal.
4. Materials that do not allow electric current to pass through them are called ____________ .
5. A switch is a simple device that either completes or ____________ a circuit.

C. Write True or False.

1. A single electric cell can also be referred to as a battery in some contexts, like in mobile phones. --------
2. An incandescent lamp has no filament. --------
3. When making a battery from two cells, the negative terminal of one cell is connected to the negative terminal of the other. --------
4. An LED will glow regardless of how its two terminals are connected in a circuit. --------
5. A drawing pin and a safety pin can be used to make a simple switch. --------

D. Define the following terms.

1. Electric Cell
2. Battery
3. Filament
4. Electric Circuit
5. Terminal (of a cell/lamp)

E. Match the columns.

	Column A		Column B
1.	Copper	(a)	Breaks the circuit
2.	Rubber	(b)	Allows current in one direction only
3.	Filament	(c)	Good electrical conductor
4.	Open Switch	(d)	Good electrical insulator
5.	LED	(e)	Glows when heated by current

F. Assertion and Reason

Instructions: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is NOT the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

e) Both A and R are false.

1. **Assertion:** Copper wires are used for making electrical circuits.
   Reason: Copper is a good insulator of electricity.
2. **Assertion:** A fused incandescent bulb does not glow.
   Reason: In a fused bulb, the filament is broken, which breaks the circuit.
3. **Assertion:** It is safe to handle electrical appliances with wet hands.
   Reason: The human body is a poor conductor of electricity.

G. Give reasons for the following statements.

1. A torch lamp glows when its switch is slid to the correct position, but not in the other position. Explain why this happens.
2. The plastic covering at the ends of electric wires is removed before connecting them in a circuit. Explain why this is necessary.
3. In circuit diagrams, symbols are used for components instead of drawing their actual pictures. Explain the reason.
4. You should never experiment directly with the main power supply at home or in school. Explain why it is dangerous.

H. Answer in brief.

1. Explain how to connect two electric cells to make a battery. Draw a simple diagram.
2. What is the difference between an incandescent lamp and an LED lamp in terms of their working and structure?
3. Describe an activity to test whether a given material is a conductor or an insulator of electricity.

I. Answer in detail.

1. Describe electricity, including its natural and artificial sources, and how it reaches our homes from a power station.
2. Explain the working principle of a simple electric cell. How are cells combined to form a battery, and why are batteries useful for bigger devices?
3. Compare incandescent and LED bulbs regarding their working, energy efficiency (heat, consumption), and lifespan.

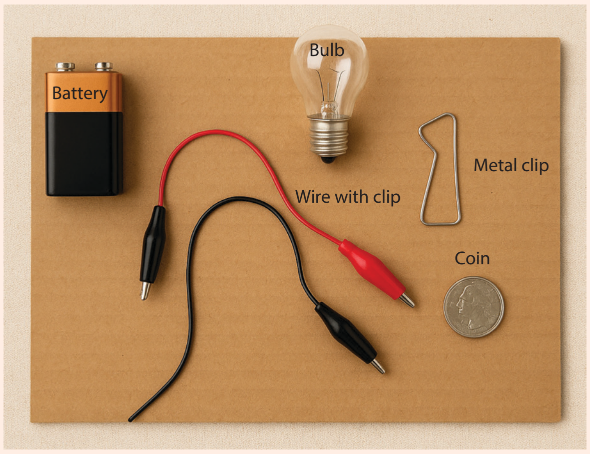
SKILL-BASED PRACTICE

Activity Time

STEM

Exploring Simple Circuits and Current Flow

Materials Required: 1 Battery (AA or 9V), 1 Bulb or LED, 2–3 Wires with clips (alligator clips if available), 1 Switch (can also use a paperclip or metal strip), Cardboard base to mount components.



Materials Required

Activity Steps:

1. **Build the Circuit**

- Place the battery, bulb, and switch on the cardboard base.
- Connect the battery to the bulb using wires.
- Insert the switch in between the circuit.

2. **Test Open and Closed Circuits**

- Close the switch (connect it). Observe the bulb.
- Open the switch (disconnect it). Observe again.

3. **Explore**

- Try reversing the battery terminals.
- Replace the switch with a simple metal paperclip.
- Note any changes in brightness or circuit function.

4. **Connections**

- **Science:** Explains how electricity flows in a closed path (circuit).
- **Technology:** Similar circuits are used in everyday appliances like torches and toys.
- **Engineering:** Designing safe circuits is essential in electrical devices.
- **Mathematics:** You can count how many components (battery, wires, bulb) are needed and draw a circuit diagram using standard symbols.

Questions:

1. What happened to the bulb when the circuit was closed and when it was open?
2. How did the switch control the flow of electricity in the circuit?
3. Why is it important to use insulated wires in circuits?
4. Can you think of two real-life examples where switches are used to control current flow?

Skills Covered: Circuit Building, Observation, Problem Solving, Cause-and-Effect Understanding

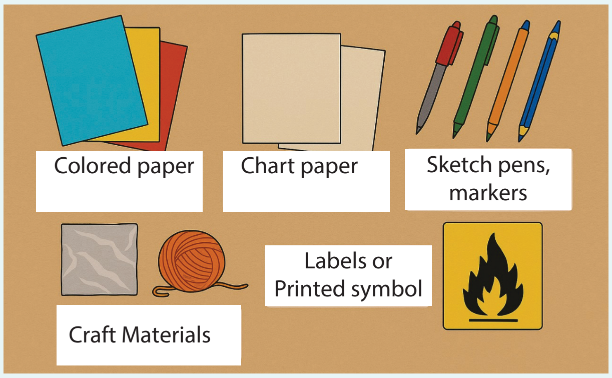
Creativity

Art

Create a Life Process Diagram Poster

Create a colourful and informative poster showing the parts of an electric circuit (cell, wires, bulb, switch) and how electricity flows through it.

Use art materials: Colored paper, Chart paper or A4 sheets, Sketch pens, markers, Craft materials (foil, yarn, etc.), Labels or printed symbols.



Materials Required

Questions:

1. What components did you show in your poster, and why are they important?
2. How did you use art to make your diagram easy to understand?

Skills Covered: Creativity, Visual Representation, Communication, Conceptual Understanding

Electricity All Around

Group Activity

Work in a group. Collect 5–6 common materials (e.g., plastic spoon, iron nail, pencil lead, foil, rubber band).

Build a test circuit using a battery and bulb. Insert each material into the circuit one at a time to test whether the bulb glows.

Questions to Answer:

1. Which materials allowed current to pass through and which didn't?
2. How did you test and classify the materials?
3. Which materials are best suited for making wires or switches? Why?

Skills Covered: Classification, Scientific Testing, Teamwork, Communication, Analysis

The Mystery of the Dim Torchlight

Case Study

Read the given passage below and answer the question:

Priya is getting ready for a school nature camp. She needs her torchlight. She remembers putting new AA cells in it a few months ago, but when she tries it now, the light is very dim, almost useless. She has a fresh pack of two AA cells. Her torchlight needs two AA cells to work.

Questions:

1. What is the first thing Priya should check or do with her torchlight and the cells?
2. When Priya puts the new cells into the torchlight, what two things must she be very careful about to ensure they are inserted correctly?
3. What is the role of the switch in Priya's torchlight?

Skills Covered: Classification, Analysis, Teamwork, Communication, Scientific Investigation

Controlling the Flow – Electric Circuits, Switches, and Diagrams

Source Based Question

"In 1800, Alessandro Volta invented the voltaic pile, the first battery. For the first time, scientists had a steady supply of electricity to use in experiments. Soon, they began joining batteries, wires, and bulbs to make simple electric circuits. To control the flow of electricity, they used a switch. When the switch was open, the circuit was broken and no current flowed. When it was closed, the circuit was complete and electricity flowed to light a bulb. By the mid-1800s, engineers started using special symbols to draw circuits on paper. These drawings, called schematic diagrams, made it easier to design and share ideas. Inventors like Thomas Edison used such diagrams when building large systems of electric lighting and power."

A voltaic pile on display in the Tempio Voltiano (the Volta Temple) near Volta's home in Como, Italy

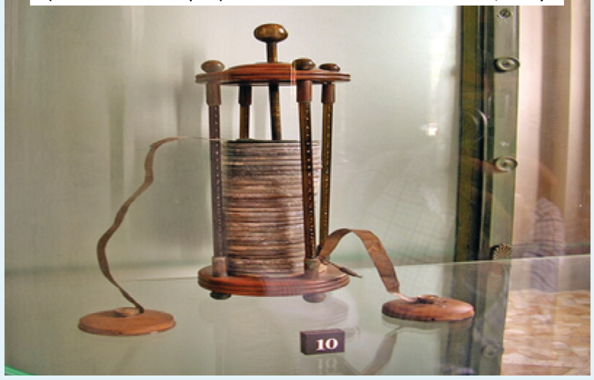


Image Credit: Wikimedia

Guiding Questions for Analysis:

1. **The First Battery**
   - Who invented the first battery, and what was it called?
   - Why was having a steady supply of electricity important for scientists?
2. **Switches in Circuits**
   - What happens when a switch is open in a circuit?
   - What happens when it is closed?
3. **Drawing Circuits**
   - What are schematic diagrams, and why did engineers start using them?
   - Give one example of a circuit symbol (e.g., switch, bulb, or battery).
4. **Critical Thinking (Linking History to Today)**
   - Imagine you lived in Edison's time. Why would circuit diagrams be useful for building electric lights for a whole town?
   - Do you think switches are just as important as bulbs in making electricity useful? Explain why.

Skills Covered: Understanding historical development of science, Observation and recall