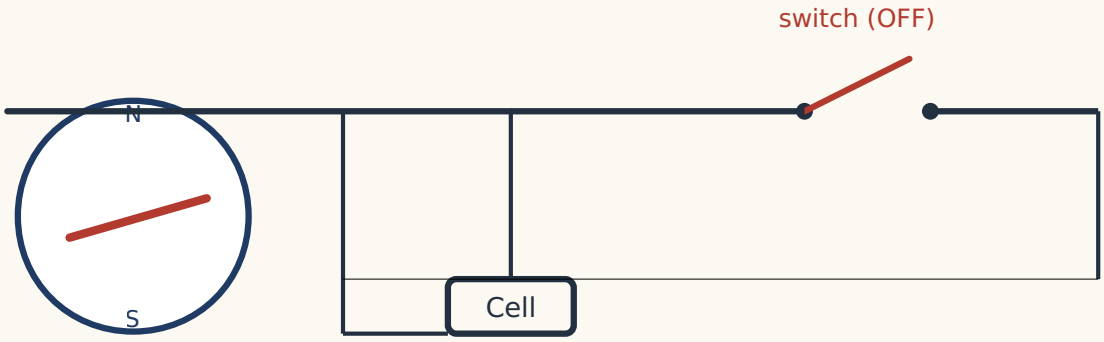
4 Electricity: Magnetic and Heating Effects

Class 8 · Science (Curiosity) · Handwritten Revision Notes

"At the science exhibition, Sumana's **lifting electromagnet** picked up iron clips just by closing a circuit – no magnet used at all! This chapter explains how electric current can behave like a magnet, how it can heat a wire, and how a cell/battery actually produces electricity."

4.1 Does an Electric Current Have a Magnetic Effect?

Activity 4.1 (Oersted's experiment): A wire carrying current is placed just above/over a magnetic compass and connected to a cell through a switch.



Switch ON → needle deflects | Switch OFF → needle returns to N-S

Fig 1: Current-carrying wire deflecting a magnetic compass (Oersted's experiment, 1820)

Observation: When current flows → compass needle deflects. When current stops → needle returns to original N–S direction.

> **Magnetic field: The region around a magnet OR a current-carrying wire where its magnetic effect can be felt (e.g. by deflection of a compass needle).**

> **Magnetic effect of electric current: When current flows through a conductor, it produces a magnetic field around it. This field disappears the moment current stops.**

Be a Scientist – Hans Christian Oersted (1777–1851)

Danish professor who, during a lecture demo, noticed a nearby compass needle deflecting whenever the circuit was opened/closed. Investigation confirmed: **electric current produces a magnetic field.** This 1820 discovery linked electricity & magnetism for the first time.

Applications of magnetic effect: electromagnets, electric bell, motors, fans, loudspeakers, etc.

4.1.1 Electromagnets

Activity 4.2/4.3: A wire is wound as a coil around an iron nail (or a hollow paper cylinder) and connected to a cell.

- Coil without iron nail + current → compass deflects a little → behaves as a **weak magnet**.
- Coil with iron nail inside + current → deflection is much more → **attracts iron paper clips**.
- Stop the current → clips fall off → magnetism disappears instantly.

> **Electromagnet: A current-carrying coil that behaves like a magnet. An iron core is added to make it stronger (used in almost all practical electromagnets).**

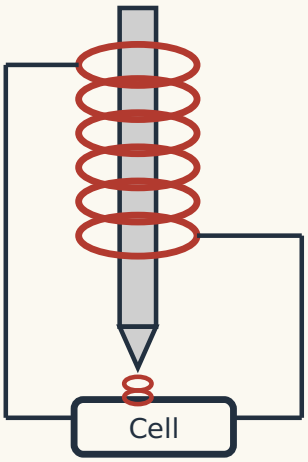


Fig 2: Electromagnet (coil + iron nail) lifting paper clips

Poles of an Electromagnet (Activity 4.4)

Like a bar magnet, an electromagnet has **two poles – North and South.** Bring a compass near each end (A, B) of the coil: unlike poles attract, so the pole of the electromagnet is opposite to the compass pole attracted to it. End A and End B always show **opposite polarity.**

Think Like a Scientist

- More cells (more current) → **stronger** magnetic field → more deflection, more clips lifted.
- **More turns** of the coil → stronger electromagnet.
- Reversing the direction of current → **reverses the poles** of the electromagnet.

Strength of electromagnet depends on: (i) amount of current, (ii) number of turns of coil.

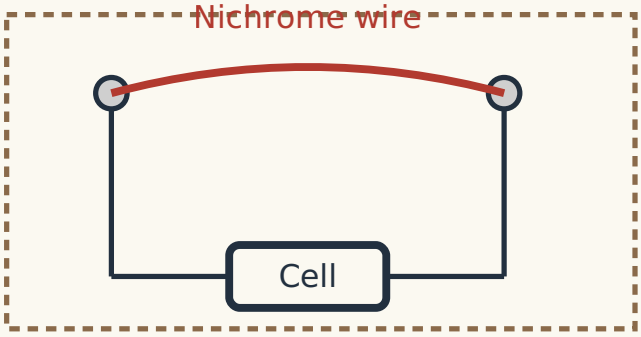
4.1.2 Lifting Electromagnets

Strong electromagnets hung from cranes; operator switches current **ON** to lift iron/steel scrap and **OFF** to release it. Widely used in factories & scrap yards to move, lift and sort heavy metal.

> *Remember!*
> Earth itself behaves like a giant magnet – molten iron moving in its core generates electric currents that create Earth's magnetic field. This field guides migratory birds/fish and shields us from harmful particles from space.

4.2 Does a Current-Carrying Wire Get Hot?

Activity 4.5: A nichrome wire is connected between two nails on a cardboard, in series with a cell and switch.



- Switch ON for ~30s, then touch wire momentarily → wire feels **warm/hot.**
- Every conductor **resists** current flow → resistance converts some electrical energy into heat.
- **Nichrome** has much higher resistance than copper of same size → heats up more → used as a heating element.

Fig 3: Heating effect – nichrome wire circuit

> **Heating effect of electric current: When current passes through a conductor, it gets heated due to the conductor's resistance to current flow.**

Think Like a Scientist

With **2 cells** (more current) for the same time, the wire heats up **more** than with 1 cell. Heat generated depends on: (i) material, (ii) thickness, (iii) length of wire, (iv) duration of current flow, and (v) magnitude of current.

Household Appliances using Heating Effect

Room heater · Electric stove · Electric kettle · Electric iron · Immersion rod · Hair dryer — all contain a **heating element** (a coil/rod, often nichrome) which may glow red-hot.

Good effect	Bad effect
Useful in heaters, kettles, irons, etc.	Energy loss (as heat) during power transmission in wires
Steel furnaces melt/recycle scrap steel	Overheating → melted plugs/sockets → fire hazard

Remember!

Household circuits use **safety devices** (fuses/MCBs) & correctly rated wires, plugs and sockets to prevent dangerous overheating.

4.3 How Does a Battery Generate Electricity?

4.3.1 Voltaic (Galvanic) Cell

- Two different metal rods (**electrodes**) dipped in an **electrolyte** (weak acid/salt solution).
- Chemical reaction between electrodes & electrolyte → produces electricity.
- Current flows (in external circuit) from **+ terminal → − terminal**.
- Chemicals get used up over time → cell becomes **'dead'**.

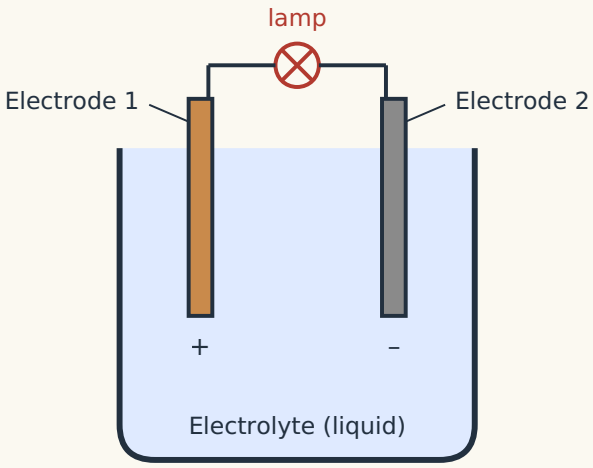


Fig 4: A simple Voltaic cell

> **Ever Heard Of... Volta & Galvani**
> Galvani (Italy, late 1700s) saw a dead frog's leg twitch when touched by two different metals and thought the electricity came from the frog. Volta proved it came from the **combination of two metals + liquid** (using saltwater-soaked paper instead of the frog) → led to the first battery!

4.3.2 Dry Cells

Most common everyday cell. Called "dry" because the electrolyte is a **thick moist paste**, not a liquid.

- **Zinc container** = negative terminal (outer casing)
- **Carbon rod** (centre, with metal cap) = positive terminal
- Paste-like electrolyte surrounds the carbon rod
- Single-use only – must be disposed of once dead

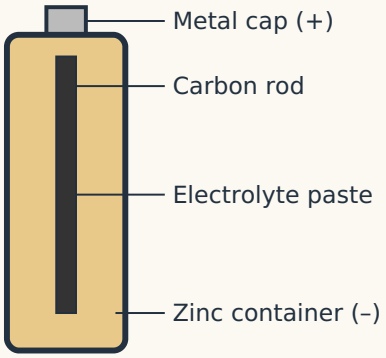


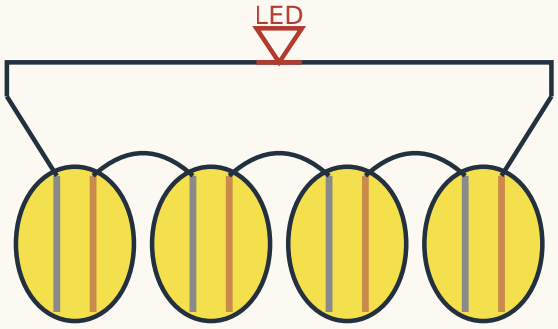
Fig 5: Structure of a dry cell

4.3.3 Rechargeable Batteries

- Can be **recharged & reused** many times → saves money, reduces waste.
- Used in: watches, phones, laptops, tablets, inverters, electric vehicles.
- Wear out slowly after many charge/discharge cycles (that's why an old phone needs charging more often!).
- **Lithium-ion (Li-ion)** battery – most common rechargeable battery today; uses lithium & cobalt.
- **Solid-state batteries** (future tech) – replace liquid/paste electrolyte with solid material → safer, faster charging, longer life.

Remember!

Even a "dead" battery isn't fully safe – it may still contain acids & metals (lead, cadmium, nickel, lithium) that are harmful if thrown in regular garbage. Always dispose of batteries at an **e-waste recycling facility.**



iron nail (grey) | copper wire (orange) inserted in lemon (electrolyte)

Fig 6: Lemon cell (Activity 4.6) – lemons in series light up an LED

Lemon cell: copper wire & iron nail inserted in a lemon (kept apart) → lemon juice acts as the electrolyte → 5–6 lemons joined in series can light an LED.

Common Voltaic-cell metal pairs: zinc/copper, zinc/silver, aluminium/copper, iron/copper, magnesium/copper, lead/copper. (Copper acts as + electrode; zinc as – electrode, due to their chemical properties.)

Snapshot – Quick Recap

- Current-carrying conductor → produces a **magnetic field** (magnetic effect of current).
- Current-carrying coil that behaves as a magnet = **electromagnet** (stronger with an iron core).
- Heat produced due to a conductor's resistance to current = **heating effect of current.**
- A cell/battery generates current through a **chemical reaction** inside it.
- **Rechargeable** batteries can be recharged & reused multiple times.

Key Terms & Quick Revision

Term	Meaning
Magnetic field	Region around a magnet/current-carrying wire where its magnetic effect can be felt
Electromagnet	A current-carrying coil (usually with iron core) that behaves as a magnet
Heating effect	Heat produced in a conductor due to its resistance to current flow
Nichrome	Alloy with high resistance; used as heating element in appliances
Electrolyte	Liquid/paste in a cell that conducts electricity (acid/salt solution or paste)
Electrode	Metal rod dipped in electrolyte, through which current enters/leaves the cell
Dry cell	Common single-use cell with zinc container (–) and carbon rod (+), paste electrolyte
Rechargeable battery	Battery that can be recharged & reused many times (e.g. Li-ion)

Factors affecting Electromagnet strength

1. Amount of current (more cells → stronger)
2. Number of turns of coil (more turns → stronger)
3. Presence of iron core (makes it much stronger)

Factors affecting Heat produced in a wire

1. Material of the wire (e.g., nichrome > copper)
2. Thickness of the wire
3. Length of the wire
4. Magnitude of current
5. Duration for which current flows

Quick check – True/False style:

- **A coil becomes an electromagnet only when current flows through it → True**
- **A single cell electromagnet attracts more clips than a 2-cell electromagnet → False**
- **Both heating & magnetic effects occur together in a current-carrying nichrome wire → True**

Remember!

Exam tip: Diagram-based questions (Oersted's setup, electromagnet, Voltaic cell, dry cell, lemon cell) are frequently asked – practise labelling each diagram along with one line on "why it works".