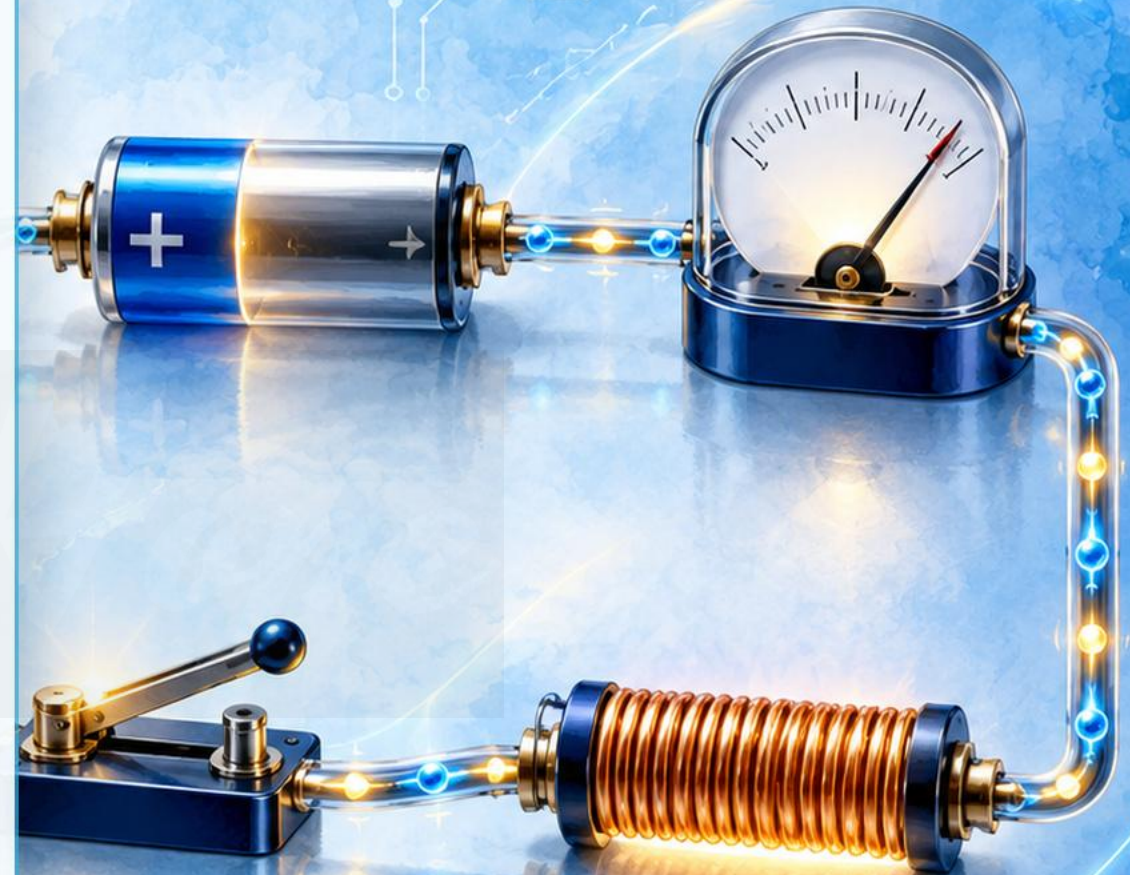


PHYSICS • CLASS 12

CHAPTER 3

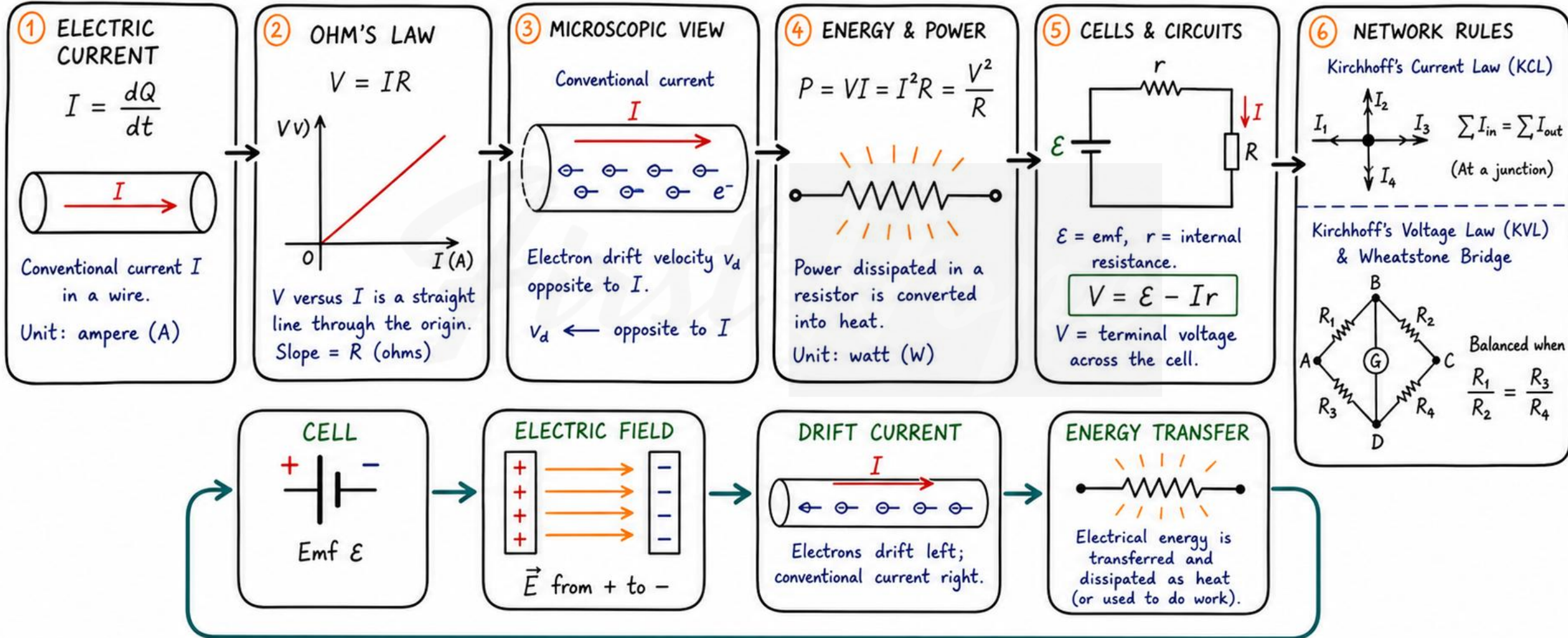
Current Electricity

CHAPTER NOTES



CURRENT ELECTRICITY

Current electricity studies the directed motion of charge and the transfer of electrical energy in circuits.

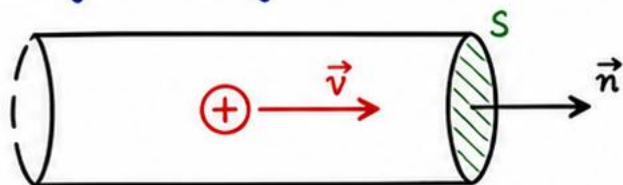


CHARGE IS CONSERVED • ENERGY IS TRANSFERRED • CIRCUIT LAWS CONNECT THE TWO

ELECTRIC CURRENT — DEFINITION & SIGN

1. DEFINITION OF CURRENT

Consider a conductor with cross-sectional area S . Let $\vec{n}$ be the unit normal to S pointing to the right.



A small amount of charge ΔQ crosses S in a time Δt in the direction of $\vec{n}$.

- Steady current: $I = \frac{Q}{t}$
- Instantaneous current: $I = \lim_{\Delta t \rightarrow 0} \frac{\Delta Q}{\Delta t} = \frac{dQ}{dt}$
- I = net charge crossing the cross-section per unit time.

2. SIGN CONVENTION

Conventional current flows in the direction in which positive charge would move.

(a) Positive charges moving right



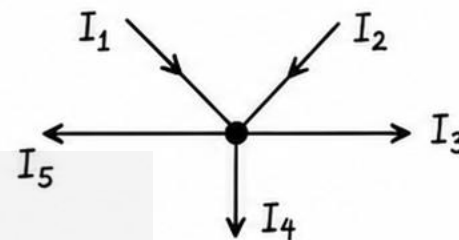
(b) Negative charges moving left



Conventional current follows positive-charge motion.

3. CURRENT IS A SCALAR

At a junction, use an assumed reference direction for each branch.



Arrows indicate an assumed reference direction.

- Currents add algebraically, not by vector addition.
- Kirchhoff's current law (KCL): $\sum I = 0$ (sum of incoming currents = sum of outgoing currents)
- General surface form: $I = \int_S \vec{j} \cdot d\vec{A}$ where $\vec{j}$ is current density ($A m^{-2}$).

4. SI UNIT OF CURRENT

The SI unit of electric current is ampere (A). By definition,

$$1 A = 1 C s^{-1}$$

5. MODERN DEFINITION OF AMPERE (SINCE 2019)

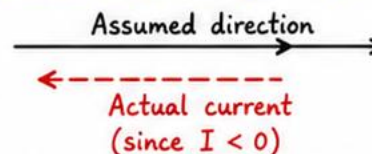
Since 2019, the ampere is defined by fixing the elementary charge exactly:

$$e = 1.602176634 \times 10^{-19} C$$

This fixed value of e underpins the ampere via the quantum electrical standards.

6. QUICK CHECK

If a calculated current I is negative, it means the actual flow of charge is opposite to the assumed reference direction (arrow).

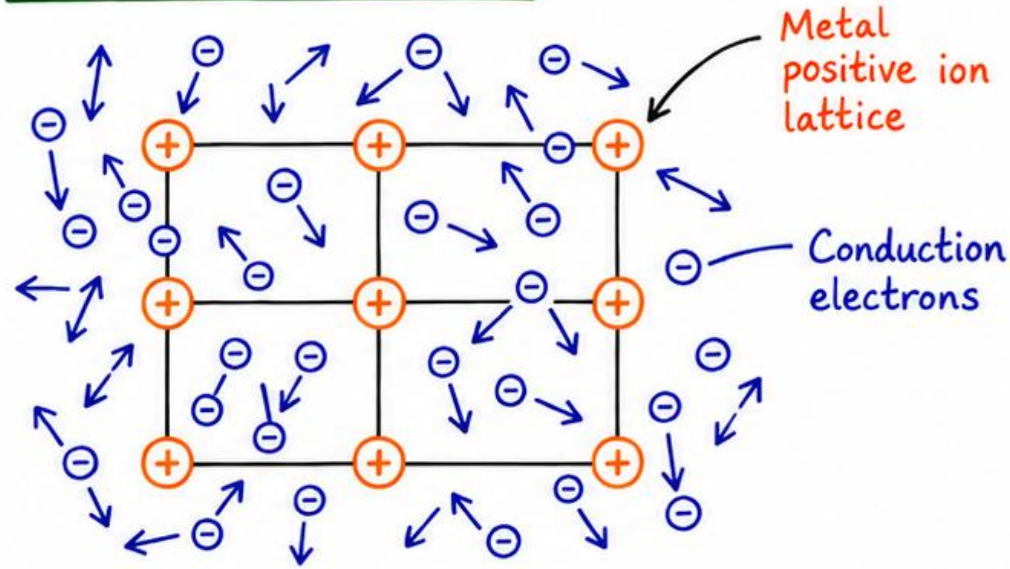


Numerical value gives magnitude; the sign gives the direction relative to the assumed arrow.

CURRENT IN CONDUCTORS

Part 1 — No applied field and cell connected

1) NO APPLIED FIELD



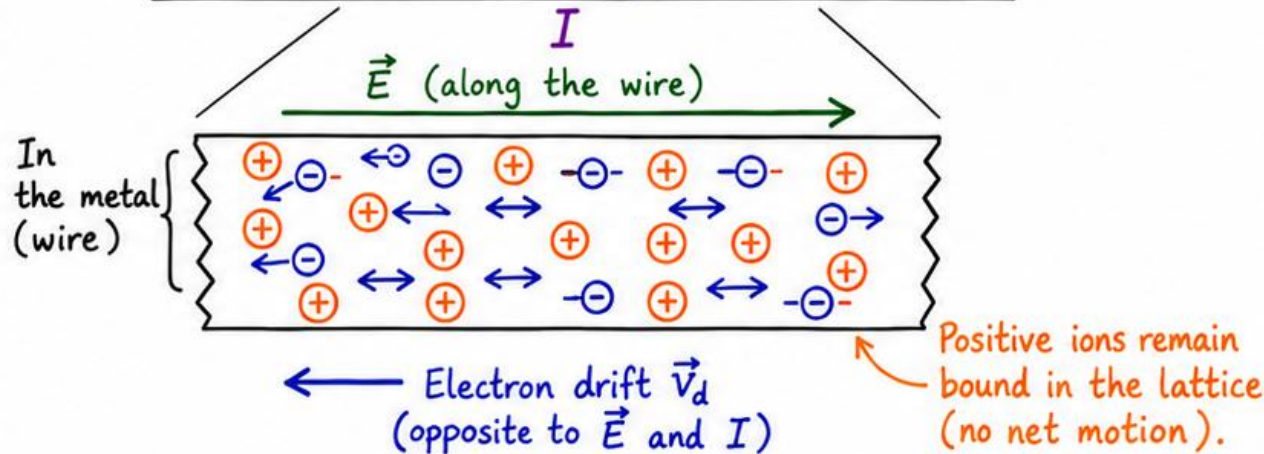
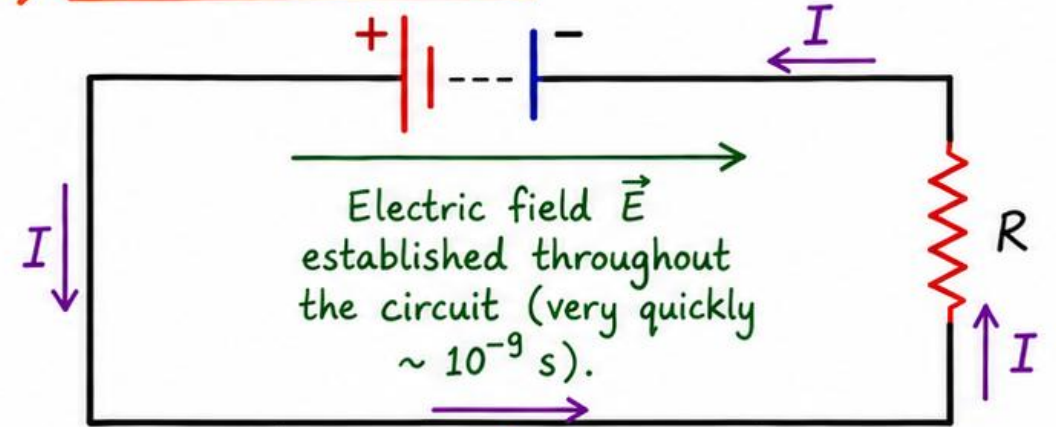
- Electrons in a metal move with random thermal velocities due to collisions with ions.
- Directions are completely random.
- Vector average of velocity of electrons,

$$\langle \vec{v} \rangle = 0$$

- Hence, drift velocity $v_d = 0$ and current $I = 0$.

Frequent collisions randomise the electron motion and destroy any systematic drift.

2) CELL CONNECTED



- The electric field $\vec{E}$ sets up a small drift of electrons.
- Electrons drift opposite to $\vec{E}$ (and opposite to I).
- Conventional current I is along $\vec{E}$.
- Current in the metal is due to electron drift.

CURRENT IN CONDUCTORS

Part 2 – Steady current and electrolytes

3) STEADY CURRENT

- The cell (battery) supplies energy to the charges and maintains terminal charge separation.
- A steady electric field persists throughout the circuit.
- Electron drift is very slow:

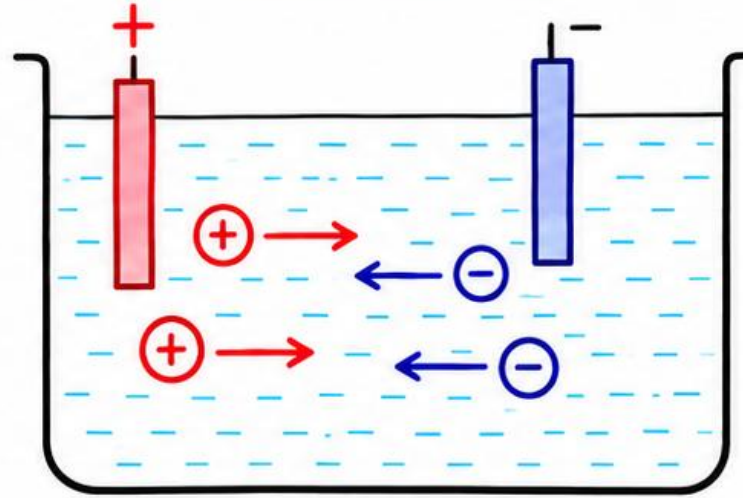
$$v_d \sim 10^{-4} \text{ to } 10^{-3} \text{ m s}^{-1}$$

(much smaller than thermal speed $\sim 10^5 \text{ m s}^{-1}$).

- Field information propagates rapidly:

$$v_{\text{signal}} \approx c \approx 3 \times 10^8 \text{ m s}^{-1}$$

IN ELECTROLYTES



Cations (+) move towards cathode (-)
→ in direction of $\vec{E}$
(same as I)

Anions (-) move towards anode (+)
→ opposite to $\vec{E}$
(opposite to I)

Both ions carry current in opposite physical directions but contribute to the same conventional current I .
(Their contributions add algebraically.)

☆ A battery does not create charge; it maintains the electric field that drives existing charge carriers. ☆

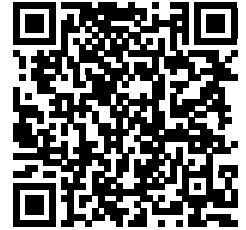


FREE PREVIEW

[Click here to visit our website](#)

SCHOOL NOTES & NCERT SOLUTIONS

Complete notes and
NCERT solutions are
available on
FirstHope app only.



[Scan or click here](#)

Click here to get the app



Available on Google Play

JOIN THE FIRSTHOPE COMMUNITY

Join our Telegram channel

Click here to join Telegram



[Scan or click here](#)

@FirstHope_CBSE_Notes

Instagram

@firsthope.school

[Click here to follow >](#)

YouTube channel

@firsthope.school

[Click here to watch >](#)

FirstHope website

firsthope.co.in

[Click here to visit our website >](#)

CBSE / Class 9 / Class 10 / Class 11 / Class 12

Preview notes and NCERT solutions. Full PDFs in the FirstHope app.