Intensive energy training course

From spark to battery

the history of electricity and batteries

Co-funded by the European Union

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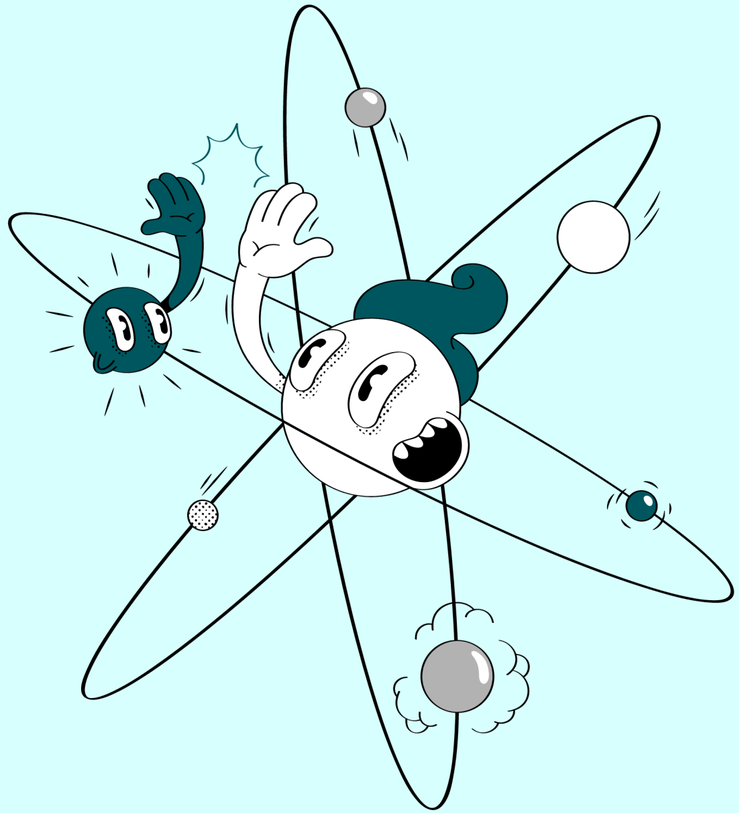
What is electric current?

Flow of electric charges (usually electrons)
Like water flowing through a pipe – but it's electrons instead of water.

⚡ Happens when voltage is applied (e.g., from a battery)

🔋 Current delivers energy to devices

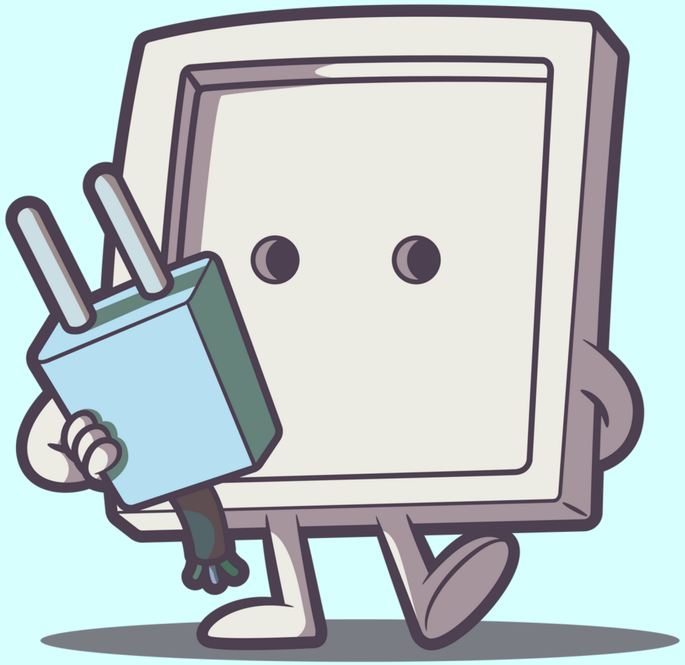


What carries current?

🟢 **Conductor** – easily conducts electricity
e.g. copper, aluminum – electrons flow freely

🟡 **Semiconductor** – conducts under certain conditions
e.g. silicon, germanium – affected by heat, light, or voltage

🔴 **Insulator** – barely conducts electricity
e.g. glass, rubber, plastic – electrons are "trapped"

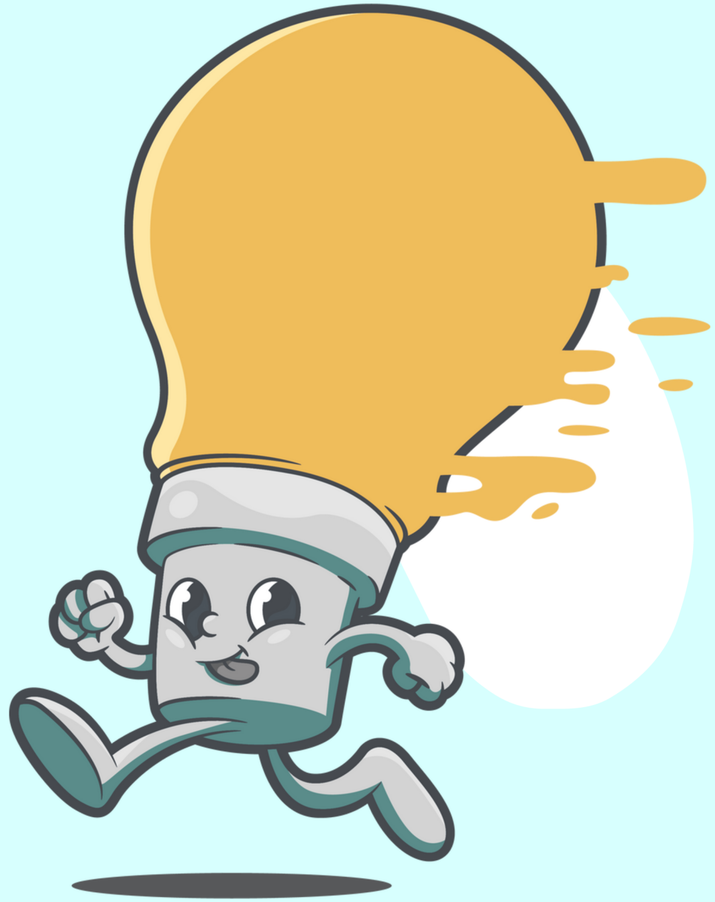


What carries current?

Electrical signals (like turning on a light) **travel close to the speed of light**
Electrons themselves move just a **few millimeters per second**

Analogy:
Imagine a pipe full of marbles.
Push one in on one end, and one pops out the other – almost instantly.
That's how current works!

Fun fact:
In a 1-meter wire, electrons may take minutes or even hours to travel the full length, but the effect (e.g., lighting a bulb) happens in fractions of a second

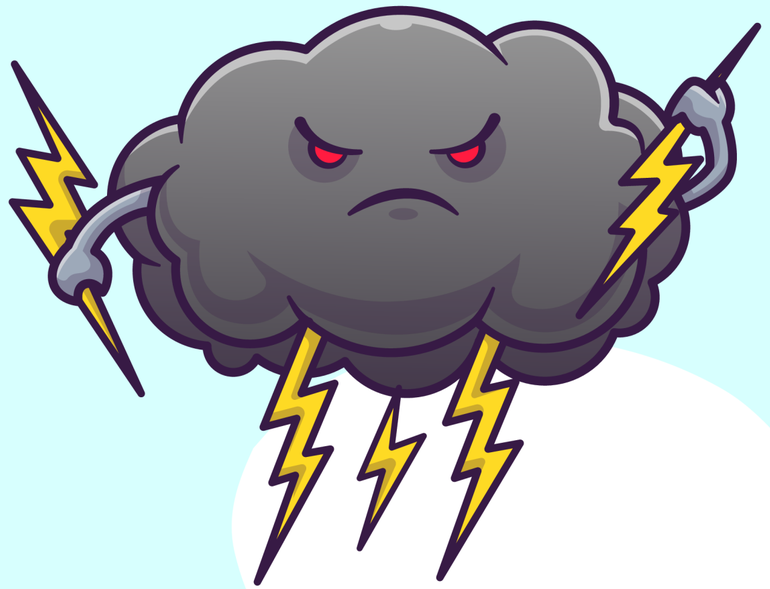


What don’t we know yet about electricity?

We know the value (1.602×10^{-19} C), **but not why** it’s that number – it’s one of the biggest puzzles in physics.

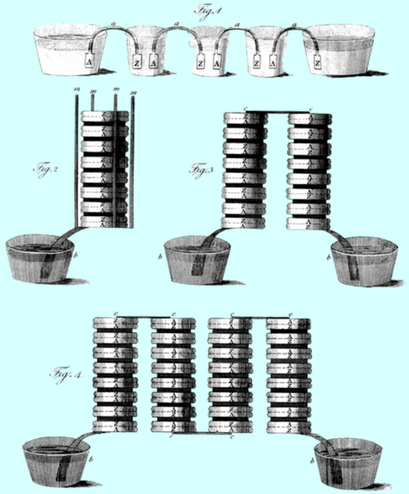
Superconductivity – electricity with zero resistance – some materials can carry current without energy loss, but only when extremely cold. If we find a room-temperature superconductor, it could revolutionize the world (transport, energy, electronics).

Ball lightning – a phenomenon science can’t fully explain. People have seen glowing balls of light during storms, sometimes inside buildings. But no one knows what they really are – plasma? charged air? optical illusion?



The early days of electricity

600 BC: Rubbing amber attracted small objects (first record of static electricity)
18th century: Luigi Galvani. frog legs twitched when touched with metal – he thought it was “animal electricity”
Alessandro Volta (1800): Built the first man-made source of continuous current – the Voltaic pile (Metal + salt-soaked cloth = voltage between layers)



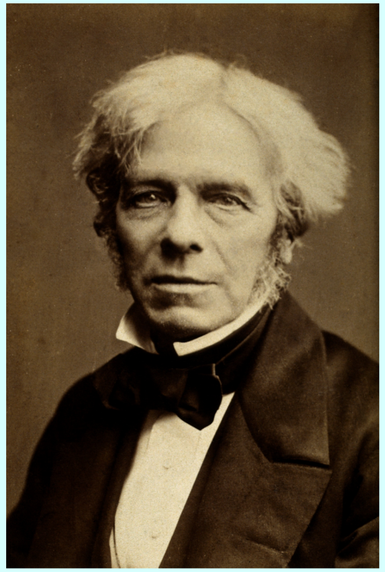
Electricity changes the world: 19th century

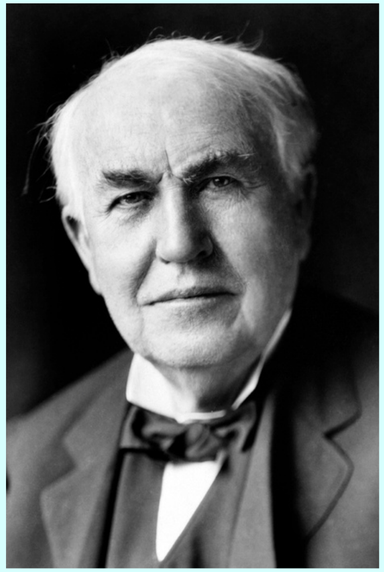
Michael Faraday – discovered electromagnetic induction (basis of motors and generators)

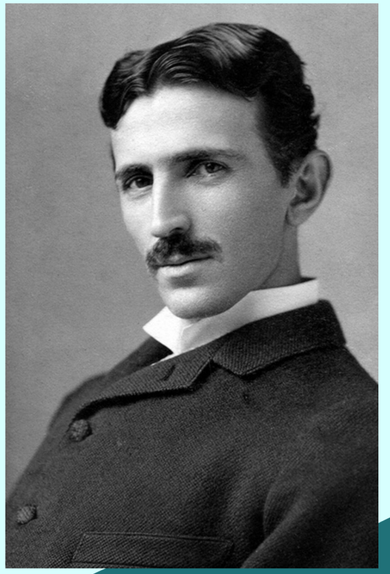
Thomas Edison – invented the practical light bulb and DC power station

Nikola Tesla – promoted AC current, transformer systems

Telegraphs, phones, electric motors – electricity enters daily life





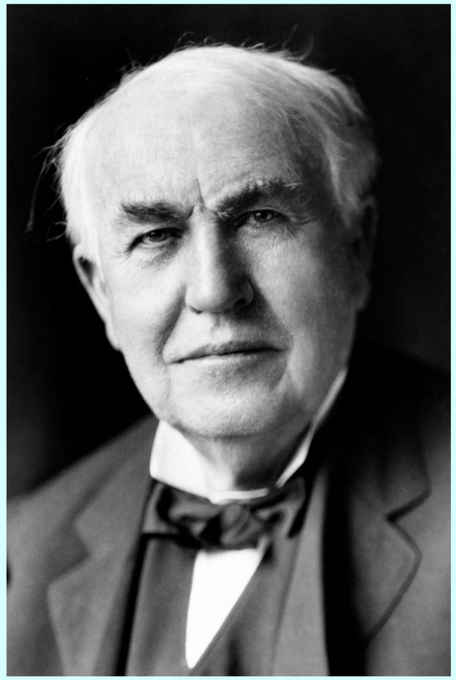


ELECTRICITY IN THE 20TH AND 21ST CENTURY

MODERN WORLD POWERED BY ELECTRICITY

Portable energy – batteries, rechargeable cells
Computers, TVs, internet – the digital age
Electric cars, smartphones, renewables – mobility and green power
Demand keeps growing – how do we produce and store energy?

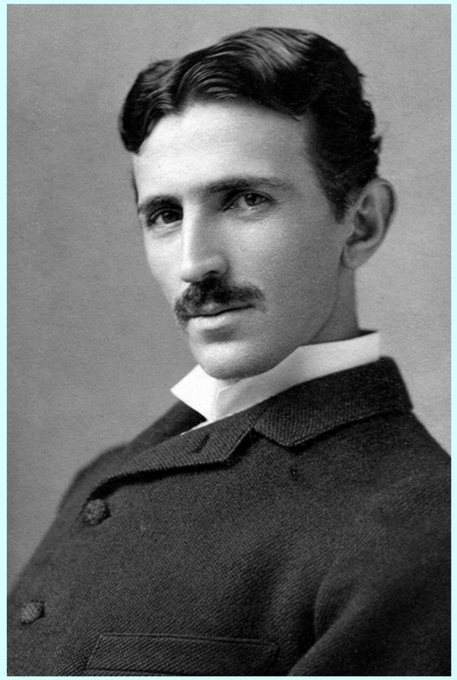
Types of current: DC and AC



Edison – supported direct current (DC)
Direct current (DC) – flows in one direction

Tesla – promoted alternating current (AC)
Alternating current (AC) – changes direction regularly (50 Hz in Europe)

Edison tried to discredit AC – said it was dangerous
AC won – easier to transmit over long distances

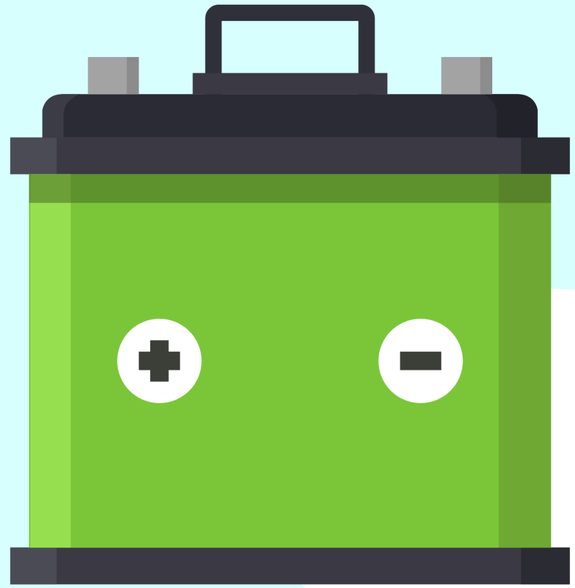


The invention of rechargeable batteries

Why did we need “portable electricity”?
Power from a socket works only in one place
But **we needed energy on the go, in the field, anytime**
Rechargeable batteries were created because:

- We had to power devices far from any grid
- We wanted to store energy for later – for lamps, phones, signals
- Railways, telegraphs, boats, lighthouses needed mobile power

The solution: lead-acid battery (1859, Gaston Planté).
First battery that **could be recharged** many times



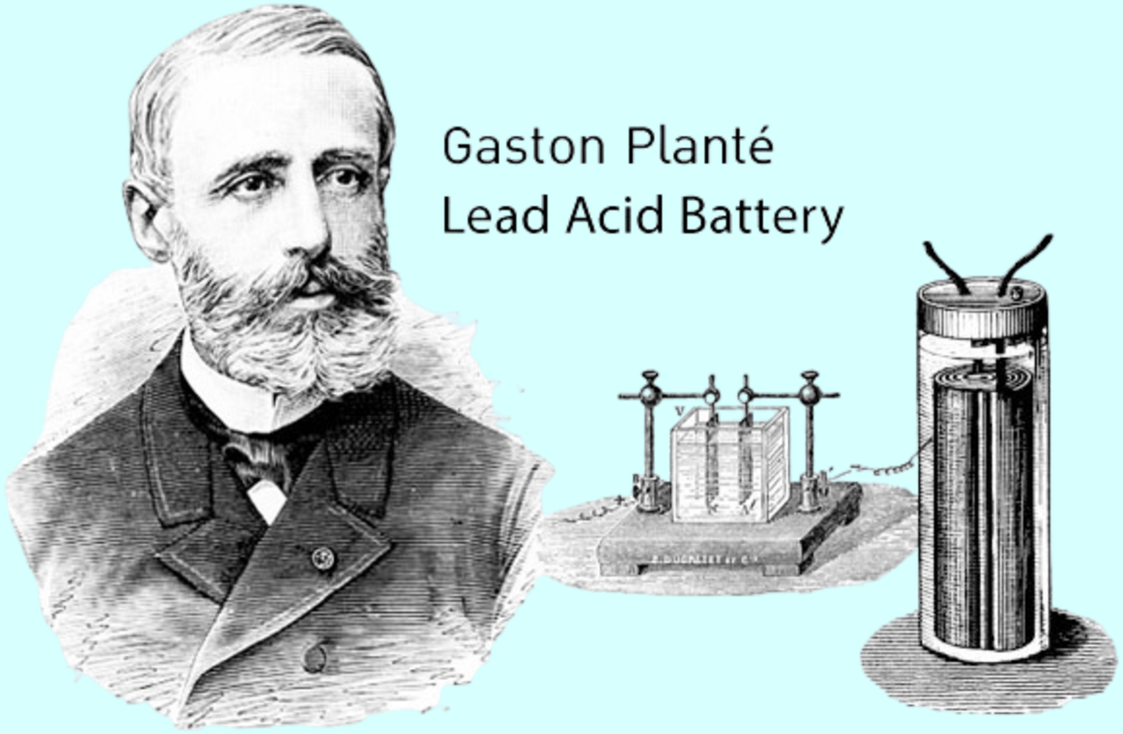
The very first energy storage devices

🐸 1780s – Galvani’s frog experiments
Seen today as the roots of electrochemistry

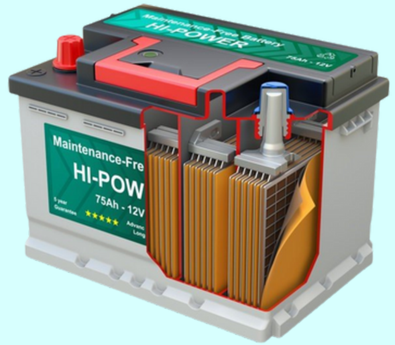
1800 – Voltaic pile
First battery: copper, zinc, acid-soaked cloth

1840s–70s – early disposable batteries (Leclanché, Daniell)
But they couldn’t be recharged

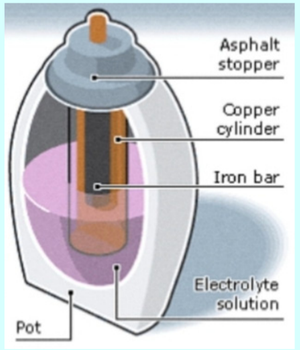
1859 – Gaston Planté and the lead-acid battery



First rechargeable battery
Electrodes: lead + lead dioxide
Electrolyte: sulfuric acid
Still used in cars and backup systems



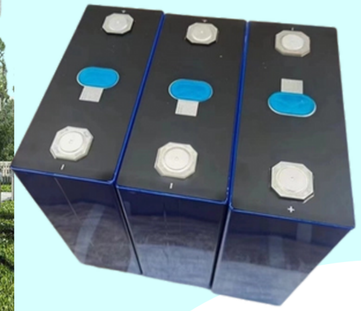
Unusual and experimental designs of rechargeable batteries



Modern battery technologies – where and why they are used?

Technology	Applications	Advantages	Drawbacks
🔋 **Li-ion (LCO, NMC)**	Smartphones, laptops, EVs	High energy density, compact	Expensive, aging over time
🔴 **$LiFePO_4$ (LFP)**	E-buses, energy storage	Durable, safer	Lower energy density
⚡ **Li-polymer**	Drones, RC devices, wearables	Very light and thin	Sensitive to damage
🟡 **NiMH**	Toys, tools, older cameras	Cheap, easy to find	Self-discharge, fewer cycles
🔵 **Sodium-ion**	New energy storage systems	Cheap, no lithium	Still under development
🧪 **Supercapacitors**	Backup, regenerative braking	Ultra-fast charge/discharge	Low capacity

Where and which batteries are used today?



How to take care of batteries so they last longer?

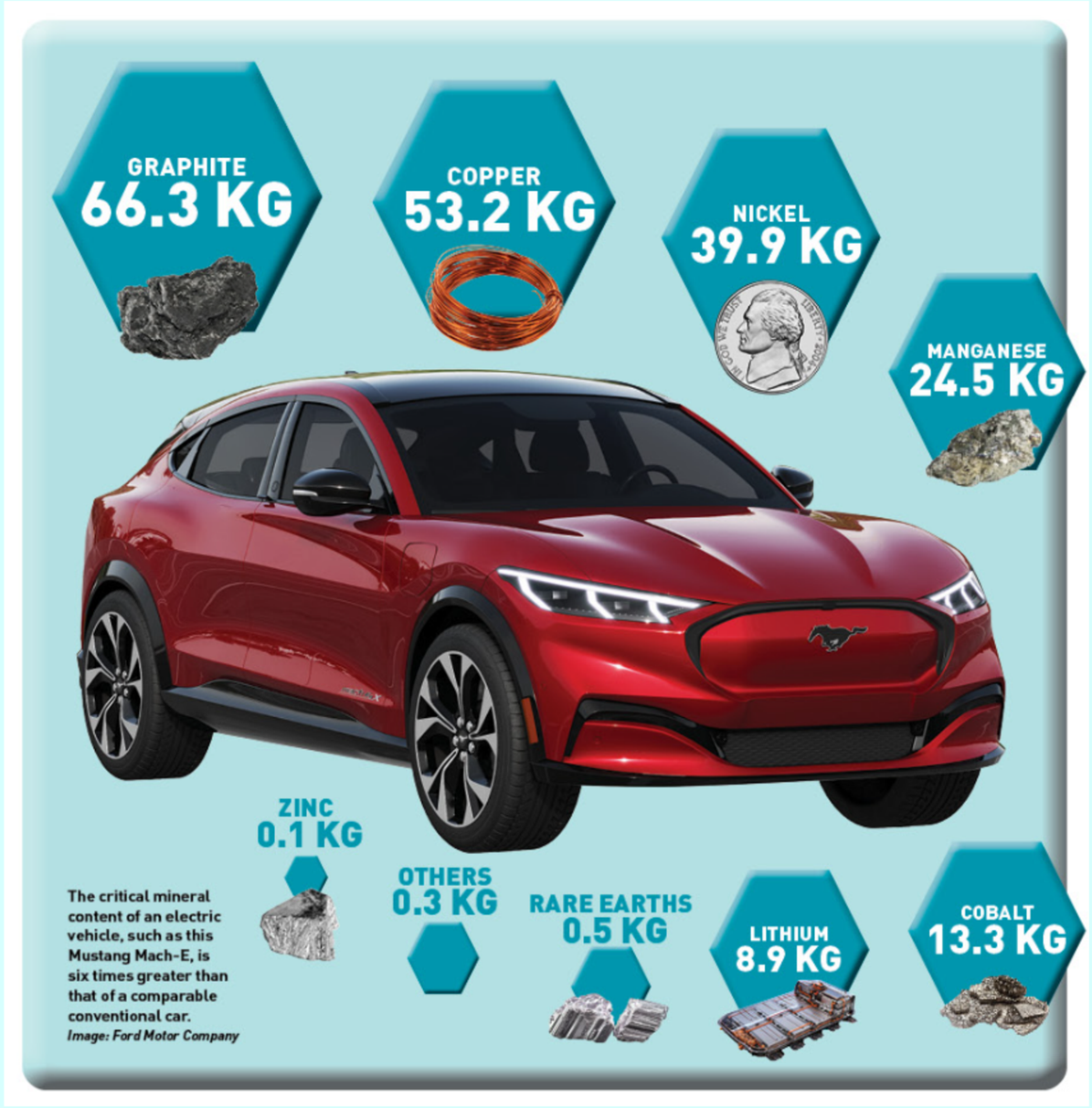
- Avoid full discharges – keep charge between 20–80%
- Avoid charging to 100% all the time, especially overnight
- Protect from extreme heat or cold
- Don’t fast charge daily, unless needed
- Avoid storing batteries fully charged or fully empty for long periods

What are the global challenges in battery development?

Strategic raw materials
Lithium, cobalt, nickel, graphite – mined in Africa, South America, China. Often linked to exploitation, conflict zones, environmental destruction

Battery waste and recycling
Most batteries are not properly recycled. Landfills = fire hazard, chemical leakage, soil and water pollution

Growing demand
By 2030, battery-powered devices may double or triple. This means more energy use, more mining, more emissions (battery production is energy-intensive)



https://www.asme.org/topics-resources/content/infographic-electric-vehicles-need-imported-minerals

Where is battery technology heading?

New chemistries:
- Sodium, magnesium, sulfur, glass or sand-based
- No cobalt or lithium → cheaper and more sustainable

Solid-state batteries:
- Solid electrolyte = safer, denser, fire-proof

Better recycling & circular economy:
- Cell disassembly, metal recovery (Ni, Co, Li, Al)
- Second life for EV batteries (e.g., home storage)

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Thank You for Your Attention

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