
Faraday Experiment — How It Works (Version 1.0)

Young Einstein Science Kits

Ages 7+ · Premium Minimal Edition

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1. Introduction

This kit recreates Michael Faraday's groundbreaking 1831 discovery: **moving a magnet near a coil of wire generates electricity**. Pupils use real scientific equipment — copper coils, magnets, galvanometers, motors, and compasses — to explore electromagnetic induction through hands-on investigation.

Designed for **KS2–KS3**, the activity supports science lessons, STEM days, clubs, and home learning.

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2. The Science Behind the Experiment

2.1 Electromagnetic Induction

A changing magnetic field creates an electric current in a conductor.

- Magnet moves **into** the coil → current
- Magnet moves **out** → current in the opposite direction
- Magnet held still → **no current**

This is Faraday's Law of Induction — the foundation of modern electricity generation.

2.2 What Happens Inside the Wire

Electricity is the movement of **electrons**.

- Electrons move freely through metals
- **Protons and neutrons stay tightly packed in the nucleus — they do not move during this experiment**
- Only electrons respond to the changing magnetic field

A changing magnetic field pushes electrons through the coil, creating a measurable current.

2.3 Energy Transfer

This experiment demonstrates the First Law of Thermodynamics: **energy cannot be created or destroyed — only transferred**.

When pupils move the magnet:

- Their **kinetic energy**
- Converts into **electrical energy** in the coil
- Detected by the galvanometer or used to power the motor

2.4 Faraday → Maxwell → Einstein

- **Faraday (1831):** discovered induction
- **Maxwell (1860s):** unified electricity and magnetism
- **Einstein (1905):** showed induction works the same whether the magnet moves or the coil moves

Einstein credited Faraday's experiment as a major inspiration.

2.5 Real-World Applications

Every generator — wind turbines, power stations, bike dynamos — uses this same principle.

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3. What Pupils Will Learn

- How electricity is generated by moving a magnet near a coil
- That electric current is the movement of electrons
- How energy transfers from motion to electricity
- How to read a galvanometer
- How to predict, test, observe, and explain results
- How Faraday's discovery links to modern power generation

A printable **Pupil Worksheet** is included.

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4. Curriculum Links

KS2

- Electricity: circuits, conductors, switches
- Forces & Magnets: magnetic fields, attraction/repulsion
- Working Scientifically: prediction, observation, recording

KS3

- Electricity & Magnetism: current, fields, induction
- Energy: transfer and conservation
- Matter: electrons vs protons/neutrons
- Scientific Enquiry: variables, fair testing, data interpretation

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5. Enquiry-Based Learning Sequence

Predict — What happens when the magnet moves fast, slow, or not at all
Observe — Watch the galvanometer needle move
Test Variables — Speed, number of magnets, distance, direction, coil orientation
Explain — Use magnetic fields, electron movement, and energy transfer

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6. What's Inside the Kit

- Copper Coil
- Ring Magnets (x6)
- Galvanometer
- Connecting Wires (x2)
- Motor + Propeller
- Compass
- Levitation Pole

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7. Age & Safety Guidance

Designed for ages 7+ with normal classroom or home supervision.
All components are safe for handling, and the activity uses low-risk magnets and simple circuits.

Caution: Contains small magnets. Individuals with pacemakers or implanted medical devices should avoid close, prolonged contact.

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8. Extension Activities

- **Powering a Motor** — Use generated electricity to spin the motor
- **Mapping Magnetic Fields** — Explore field direction and strength
- **Levitation Pole** — Investigate magnetic repulsion and balanced forces
- **Coil Orientation** — Test how rotating the coil affects induction
- **Real-World Links** — Research wind turbines, dynamos, and generators

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9. Historical Timeline

1820s — Oersted links electricity and magnetism
1831 — Faraday discovers induction
1840s–1860s — Joule, Helmholtz, Clausius develop energy conservation
1860s — Maxwell unifies electricity and magnetism
1880s — Generators spread worldwide
1905 — Einstein explains induction symmetry

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10. Summary

This kit gives pupils a rare chance to recreate a world-changing scientific discovery using real equipment. They learn how electricity is generated, how energy transfers, and how modern power systems work — all through hands-on exploration.

Includes:

- Full Teacher's Guide
- Printable Pupil Worksheet
- Clear safety notes
- Extension activities
- Curriculum alignment

Volta's Experiment — How It Works (Version 1.0)

Young Einstein Science Kits

Ages 7+

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1. Introduction

This kit recreates **Alessandro Volta's 1800 discovery** that electricity can be produced chemically using two different metals and a salty liquid. Pupils build a real working **galvanic battery** using copper, zinc, and saltwater — the same principle behind every modern battery.

Designed for **KS2–KS3**, this activity supports science lessons, STEM days, clubs, and home learning.

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2. The Science Behind the Experiment

2.1 Chemical Electricity

Volta discovered that electricity can be made when **two different metals** are placed in a salty or acidic liquid.
This creates a **chemical reaction** that pushes electrons from one metal to the other.

- Zinc releases electrons
- Copper receives electrons
- Saltwater allows ions to move between them

This flow of electrons is **electric current**.

2.2 Why Two Metals Are Needed

Different metals hold onto electrons with different strengths.

- **Zinc** gives up electrons easily
- **Copper** holds electrons more tightly

When connected through the salty water, electrons move from zinc → copper, creating a **voltage**.

This difference in electron "pull" is called **electrode potential**.

2.3 What Happens Inside Each Cell

Each test tube in your kit is a **single battery cell**.

Inside each cell:

- Zinc metal **loses electrons** (oxidation)
- Copper metal **gains electrons** (reduction)
- Saltwater allows ions to move so the reaction can continue
- Electrons travel through the wires to the LED or voltmeter

Only **electrons** move through the wires.
Protons and neutrons stay tightly packed in the nucleus and do not take part.

2.4 Adding Cells Together

One cell produces a small voltage.
When you connect **four cells in series**, the voltages **add together**.

This is why your kit can produce enough power to flash a bright red LED.

This is the same principle used in:

- AA batteries
- Phone batteries
- Electric car battery packs

2.5 Real-World Applications

Volta's discovery led directly to:

- Batteries
- Electrochemistry
- Portable electronics
- Early telegraphs
- Modern rechargeable systems

Every battery today still uses **two different materials** and a **conductive liquid or solid** to move ions.

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3. What Pupils Will Learn

Pupils will understand:

- How electricity can be created chemically
- Why two different metals are needed
- How electrons move through a circuit
- How ions move through the liquid
- How battery cells add together to increase voltage
- How Volta's discovery links to modern batteries

A printable **Pupil Worksheet** is included.

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4. Curriculum Links (KS2–KS3)

KS2

- Electricity: simple circuits, current, components
- Materials: metals, conductivity
- Working Scientifically: prediction, observation, recording

KS3

- Chemical Reactions: oxidation and reduction
- Electricity: current, voltage, series circuits
- Energy: chemical → electrical energy transfer
- Scientific Enquiry: variables, fair testing, data interpretation

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5. Enquiry-Based Learning Sequence

Predict — What will happen when the metals are placed in salty water?
Observe — Watch the voltmeter reading or LED behaviour.
Test Variables — Metal type, salt concentration, number of cells.
Explain — Use electron movement, ion movement, and energy conversion.

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6. What's Inside the Kit

- Copper plates (x4)
- Zinc plates (x4)
- Test tubes with screw caps (x4)
- Salt for making electrolyte
- Connecting wires
- LED with spade connectors
- Voltmeter (no batteries required)

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7. Age & Safety Guidance

Designed for ages 7+ with normal classroom or home supervision.
All components are safe for handling, and the activity uses low-risk materials and simple circuits.

Caution: Contains small parts. Individuals with pacemakers or implanted medical devices should avoid close, prolonged contact with magnets (if used in extensions).

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8. Extension Activities

- **Stronger Electrolytes** — Test lemon juice, vinegar, or salty water
- **Metal Combinations** — Try different metal pairs
- **Series vs Parallel** — Compare voltage and brightness
- **Electroplating** — Explore how metals can coat each other
- **Battery History** — Research Volta, Galvani, and early telegraphs

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9. Historical Timeline

1790s — Galvani observes “animal electricity”
1800 — Volta builds the first chemical battery
1830s — Telegraphs powered by voltaic cells
1850s — Daniell and Leclanché cells improve stability
1900s — Dry cells and rechargeable batteries
Today — Lithium-ion batteries power modern devices

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10. Summary

This kit gives pupils the chance to build a real working battery using simple materials. They learn how chemical reactions can produce electricity, how electrons and ions move, and how modern batteries evolved from Volta's original design.

Includes:

- Full Teacher's Guide
- Printable Pupil Worksheet
- Clear safety notes
- Extension activities
- Curriculum alignment

HOW IT WORKS — Bennet's "Detect Static Electricity" Experiment

A simple way to see invisible electric charge in action

1. What the experiment shows

Bennet's detector reveals one of the most important ideas in electrostatics:
electric charges can move, separate, and push on each other — even without touching.

When a charged balloon is brought near the metal plate, the detector responds instantly. The thin metal leaf swings away because **like charges repel**. This movement makes an invisible force visible.

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2. How a balloon becomes "charged-up"

When you rub a **latex balloon** on **hair, wool, or clothing**, two things happen:

- Different materials hold onto electrons with different strengths.
- Rubbing them together causes **electrons to transfer** from one surface to the other.
- The balloon usually **gains extra electrons**, becoming **negatively charged**.

This is called **triboelectric charging** — the same effect that makes a crackling jumper or causes a shock when you touch a door handle.

Fun fact: Why hair stands on end

When the balloon steals electrons from your hair:

- Each strand of hair becomes **positively charged**.
- All the hairs now have the **same charge**.
- Same charges repel → the hairs push away from each other → **they stand up**.

It's the same rule you'll see in the detector: **like charges repel**.

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3. Why a balloon sticks to a wall

A wall is neutral overall, but its electrons can shift slightly.

- A negatively charged balloon **pushes electrons away** from the wall's surface.
- The surface becomes slightly **positive**.

- Opposite charges attract → **the balloon sticks**.

This is called **electrostatic induction** — and it's the same principle that makes the detector respond.

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4. What happens inside the static detector

Your detector has three key parts:

1. **Metal plate** (where the charge arrives)
2. **Metal rod** (conducts charge)
3. **Thin metal leaf** (moves when charged)
4. **Plastic box** (insulates and protects the charge)

Step-by-step: how the detector reacts

a) The charged balloon comes close (but does not touch)
The electric field from the balloon reaches the metal plate.
Electrons in the metal **move instantly**, even without contact.

b) Charge separates inside the detector
Depending on the balloon's charge, electrons either move **towards** or **away from** the plate.
This leaves the plate and the leaf with the **same type of charge**.

c) Like charges repel
Because the plate and the leaf now share the same charge, the leaf is pushed away.
This is why the leaf **swings outward**.

d) The plastic box helps
The clear plastic case is an **insulator**.
It stops the charge from leaking away into the air or your hands, so the leaf stays open long enough to observe.

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5. Why the leaf moves even if the balloon never touches the metal

This is the part that amazes pupils.

The balloon's electric field is strong enough to:

- Rearrange charges inside the metal
- Create a region of like charge on the plate and leaf

- Cause repulsion without any physical contact

This demonstrates that **electric forces act at a distance** — a key idea in physics.

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6. How this simple experiment links to modern technology

Understanding "like charges repel" and "opposite charges attract" helps explain real-world systems:

Electrostatic paint spraying

Car manufacturers charge paint droplets and give the car body the opposite charge.
The paint is **attracted** to the metal and wraps around edges, reducing waste.

Powder coating

Plastic powder is charged and sprayed onto metal parts.
Opposite charges pull the powder evenly onto the surface before heating.

Laser printers & photocopiers

Toner particles are charged so they stick only to the correct parts of the drum.
Opposite charges attract → the image forms.

Air purifiers

Dust particles are charged so they can be trapped by oppositely charged plates.

Your detector is a miniature version of these technologies — it shows the same physics in a simple, hands-on way.

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7. The big idea pupils should take away

Electric charge is real, it moves, and it creates forces we can see.
Bennet's detector turns an invisible phenomenon into something physical and memorable:

- **Rubbing creates charge**
- **Charge can move without touching**
- **Like charges repel**
- **Opposite charges attract**
- **We use these effects every day**
