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FREE EBOOK

SCIENCE PROJECTS AND KITS

Electricity and Magnetism Experiments

Hands-on experiments with cells, wires, bulbs and magnets

INSIDE THIS BOOK

- Safety and your experiment kit
- Circuits, conductors and insulators
- Series and parallel circuits
- Switches and a torch
- ...and 6 more chapters, practice questions and a glossary

Beginner

Students of class 5 to 10

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Electricity and Magnetism Experiments

Eighteen safe experiments with cells, bulbs, wires and magnets, each with clear steps and an observation table to fill in. Make a conductor tester, switches, a torch, an electromagnet, a compass, a simple motor and a lemon battery, see magnetic field lines, repeat Oersted's famous experiment, and understand fuses and static electricity.

WHO IT IS FOR	Students of class 5 to 10
LEVEL	Beginner
SUBJECT AREA	Science projects and kits
WHAT IS INSIDE	10 chapters, practice questions with answers, and a glossary

HOW TO USE IT

Read one chapter at a time and try the examples as you go: on a computer, at your workbench or in your notebook. The boxes give tips, safety points and short activities. When you finish, test yourself with the practice questions and check your answers at the end. Words you may not know are explained in the glossary.



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Safety and your experiment kit

Electricity and magnetism are close cousins. A current in a wire makes a magnet, and a magnet can help make a current. In this book you will see both with your own eyes, using only cells, bulbs, wires and magnets. There are eighteen experiments. Each one has an aim, a list of things you need, steps, an observation table to copy into your notebook, and a short explanation.

Safety rules

1. Use only cells and batteries, never more than 9 V in all. Never use a wall socket, an extension board, an inverter or a mains adapter. Mains electricity can kill.
2. Never push anything into a socket. Never touch a switchboard, a fuse box or a broken wire at home.
3. Never join the + and – of a cell with a bare wire and nothing else. This is a **short circuit**: the wire and the cell get hot and the cell may leak. In the few experiments where a coil is joined almost straight across a cell, press the switch for only a few seconds at a time.
4. Never open, burn or try to recharge an ordinary cell. If a cell leaks, do not touch the paste, and wash your hands.
5. Keep small strong magnets away from young children, who might swallow them. Keep all magnets away from phones, bank cards and watches.
6. An adult should help with sharp tools and cutting. Keep iron filings away from your eyes.
7. Wash your hands after handling cells, iron filings and the fruit used for batteries. Never eat that fruit afterwards.

Your kit

Item	Used for
1.5 V cells (AA or D size) with holders for one and two cells	Most experiments
2.5 V torch bulbs with holders	Circuits

Item	Used for
Red LEDs, with 100 Ω resistors	Testers
Insulated wire and crocodile clip leads	Joining parts
Thin enamelled copper wire and sandpaper	Coils and the motor
Two bar magnets, a ring magnet and a small compass	Magnet experiments
Iron nails, steel paper clips and pins	Electromagnet
Iron filings, a sewing needle and a cork	Field lines and a compass
A thermometer	Heating effect
Drawing pins, thick cardboard and tape	Switches
Lemons, copper wire and zinc-coated (galvanised) nails	Fruit battery
Balloons and tissue paper	Static electricity

A simple digital multimeter, which measures voltage, is useful but not essential.

How to record an experiment

Before you start, write the date and your **prediction**: what you think will happen. Then do the experiment and fill in the table honestly.

REMEMBER

A prediction that turns out wrong is not a failure. Finding out that you were wrong is how science moves forward.

TIP

An LED (light emitting diode) lights only one way round. Its longer leg must go towards the + side. Always put a resistor in series with it, or it can burn out.

Circuits, conductors and insulators

A **circuit** is a complete path for electricity. Current leaves the + end of the cell, goes through wires and a bulb, and comes back to the – end. If there is a gap anywhere, the current stops. A circuit with a gap is **open**. A complete circuit is **closed**.

Drawing circuits with symbols

Scientists draw circuits with simple symbols instead of pictures. They are quick to draw and everyone understands them. Use them in your notebook.

Part	How its symbol is drawn
Wire	A straight line
Cell	A long thin line (+) beside a short thick line (–)
Battery	Two or more cell symbols side by side
Bulb	A circle with a cross inside it
Switch	A line with a gap, and a short slanting line lifted away from one side
LED	A triangle pointing at a bar, with two small arrows going out

Experiment 1: Make a bulb glow

Aim: To find which connections make a bulb glow.

You need: one 1.5 V cell, one 2.5 V torch bulb without a holder, and one wire.

A torch bulb has two contacts: the metal tip at the bottom and the metal case around the side. Inside the glass, a thin wire called the **filament** joins the two.

Steps: Try each arrangement in the table. Write your prediction first.

Arrangement	Prediction	Does it glow?
Tip on the cell's +, wire from – to the side of the bulb		
Tip on the cell's +, nothing else connected		
Side against the cell's –, wire from – to the tip		

Arrangement	Prediction	Does it glow?
Tip on the cell's -, wire from + to the side		

What it shows: The bulb glows (dimly, on one cell) only when current can pass through the filament, from one contact to the other. It glows either way round, because a bulb does not mind the direction of the current.

Experiment 2: A conductor and insulator tester

Aim: To sort materials into those that let current pass and those that do not.

You need: two cells in a holder, a bulb in a holder (or an LED with a 100 Ω resistor), three wires with crocodile clips, and things to test.

Steps:

1. Join the cells, the bulb and one wire in a line, leaving two free wire ends. These are your **probes**.
2. Touch the probes together. The bulb should glow. Your tester works.
3. Touch both probes to each object, a little apart.

Object	Material	Prediction	Glow?	Conductor or insulator
Steel spoon				
Aluminium foil				
Plastic ruler				
Rubber eraser				
Wooden stick				
Pencil lead, sharpened at both ends				
Glass bangle				
Cotton thread				

What it shows: Materials that let current pass are **conductors**: metals, and also graphite, the "lead" in a pencil. Materials that stop it are **insulators**: plastic, rubber, dry wood, glass and cloth. Wires are copper inside a plastic coat for this reason.

DID YOU KNOW

Pure water is a poor conductor, but tap water and sweat contain dissolved salts and conduct. That is why you must never touch switches with wet hands.

CHAPTER 3

Series and parallel circuits

Two bulbs can be joined in two ways. In **series**, they sit one after the other in a single path. In **parallel**, each bulb has its own path to the cells.

Experiment 3: Two bulbs in series

Aim: To see how bulbs behave when joined one after another.

You need: two cells in a holder, two identical bulbs in holders, wires.

Steps:

1. Make a circuit with one bulb and note its brightness.
2. Add the second bulb in the same path: cell → bulb 1 → bulb 2 → cell.
3. Compare the brightness. Then unscrew one bulb.

Set-up	Brightness of each bulb	When one bulb is removed
One bulb		
Two bulbs in series		

What it shows: In series, each bulb is dimmer, because the two share the push of the cells. Removing one bulb breaks the only path, so the other goes out too.

Experiment 4: Two bulbs in parallel

You need: the same things as in Experiment 3.

Steps: Join both ends of bulb 1 to the cells. Then join both ends of bulb 2 to the same two points, so each bulb has its own path. Compare the brightness and unscrew one bulb.

Set-up	Brightness of each bulb	When one bulb is removed
Two bulbs in parallel		

What it shows: In parallel, each bulb is about as bright as one bulb alone, and if one is removed the other stays lit. The cells now supply more current, so they run down faster. The wiring in your home is in parallel, which is why each fan and light can be switched on and off by itself.

Experiment 5: Cells in series

Aim: To see what happens when cells are joined one after another.

You need: two loose cells, tape, one bulb in a holder, wires.

Steps:

1. Light one bulb with one cell. Note the brightness.
2. Use two cells, + of one touching – of the next. Note the brightness.
3. Turn one cell round, so + touches +. Note what happens.

Arrangement	Voltage (if you have a meter)	Brightness
One cell		
Two cells, + to –		
Two cells, + to +		

What it shows: Cells in series add their voltages: $1.5\text{ V} + 1.5\text{ V} = 3\text{ V}$, so the bulb is brighter. When one cell is turned round, the two push against each other and cancel out, so the bulb stays dark.

SAFETY

Do not use three cells with a 2.5 V bulb. 4.5 V is too much for it and the filament may burn out.

TRY THIS

Open the cell cover of a TV remote. The cells face opposite ways side by side, but a metal strip joins them in series.

CHAPTER 4

Switches and a torch

A **switch** is a gap in a circuit that you can open and close as you wish.

Experiment 6: A paper clip switch

You need: a piece of thick cardboard, two drawing pins, a steel paper clip, a bulb circuit.

Steps:

1. Push one drawing pin through the end of the paper clip into the cardboard. Push the second pin in so that the clip can swing round and touch it.
2. Wrap one circuit wire under each pin before pressing it down.
3. Swing the clip on and off the second pin.

Clip position	Circuit open or closed?	Bulb
Touching the second pin		
Away from the second pin		

What it shows: Touching the clip to the pin closes the gap, so current flows and the bulb lights.

TIP

If the bulb flickers, rub the paper clip and the pin heads with sandpaper. Rust and dirt are poor conductors.

Experiment 7: A two-way switch, like a staircase light

Aim: To control one bulb from two places.

You need: two cells in a holder, a bulb in a holder, cardboard, six drawing pins, two paper clips, long wires.

Steps:

1. Make two switches. In each, a paper clip swings on a centre pin, and two more pins, marked A and B, sit where the clip can touch either one.
2. Join pin A of switch 1 to pin A of switch 2, and pin B to pin B, with long wires.
3. Join the cell's + to the centre pin of switch 1. Join the centre pin of switch 2 to the bulb, and the bulb to the cell's -.

Switch 1	Switch 2	Bulb on or off?
A	A	
A	B	
B	A	
B	B	

What it shows: The bulb lights when both clips touch the same letter, because then there is a complete path. Moving either clip changes the bulb, so you can switch it from either end, just like a light at the top and bottom of a staircase.

Experiment 8: Make a torch

You need: a cardboard tube from a kitchen roll, two AA cells in a holder, a bulb in a holder, aluminium foil, a paper clip switch made on a strip of card, tape.

Steps:

1. Tape the cell holder inside the tube.
2. Fix the bulb holder at one end, so the bulb points out of the tube.
3. Wire the cells, the switch (taped on the outside) and the bulb in series.
4. Make a cone of foil, shiny side in, with a hole for the bulb. Fit it round the bulb.
5. Shine the torch on a wall 1 m away, first without the foil cone, then with it.

Test	Size of the light patch	Brightness
Without reflector		

Test	Size of the light patch	Brightness
With foil reflector		

What it shows: The shiny cone, called a **reflector**, bounces light forward into a beam, so the patch is smaller and brighter.

EXAMPLE

Rohan in Pune found that his torch beam was patchy. He smoothed the foil cone so it had no creases, and the beam became much more even. A smooth, curved reflector sends the light out together.

CHAPTER 5

Magnets and magnetic fields

Every magnet has two ends, called **poles**: a north-seeking pole (N) and a south-seeking pole (S). The space around a magnet where it pushes or pulls is its **magnetic field**.

Experiment 9: What does a magnet attract?

Aim: To find which materials are magnetic, and how poles behave.

You need: two bar magnets and the objects in the table.

Steps:

1. Touch a magnet to each object and record whether it is pulled.
2. Bring the N pole of one magnet near the N pole of another, then near the S pole.

Object	Prediction	Attracted?
Iron nail		
Steel paper clip		
Aluminium foil		
Copper wire		
Steel spoon		

Object	Prediction	Attracted?
Coin		
Plastic button		

Poles brought together	Pull together or push apart?
N and N	
N and S	
S and S	

What it shows: Magnets attract iron, most kinds of steel, nickel and cobalt. They do not attract aluminium, copper, plastic or wood. Some steel spoons are attracted and some are not, because there are different kinds of steel. Like poles repel (push apart); unlike poles attract.

Experiment 10: Seeing field lines with iron filings

You need: a bar magnet, a sheet of stiff paper or a thin plastic file, iron filings in a shaker (an old salt shaker works).

Steps:

1. Lay the paper over the magnet.
2. Sprinkle filings thinly over the paper and tap it gently.
3. Repeat with two magnets, first N facing S, then N facing N, with a 3 cm gap.

Set-up	Pattern you see (draw it)
One bar magnet	
Two magnets, N facing S	
Two magnets, N facing N	

What it shows: The filings line up along **magnetic field lines**, which run from the N pole round to the S pole and crowd together near the poles, where the field is strongest. With N facing S the lines join across the gap. With N facing N they push away from each other.

TIP

Put the magnet inside a plastic bag first. Filings are very hard to wipe off a bare magnet.

Experiment 11: Make a compass

You need: a steel sewing needle, a bar magnet, a thin slice of cork or thermocol, a bowl of water.

Steps:

1. Stroke the needle about 40 times from end to end with one pole of the magnet, always in the same direction, lifting the magnet well away at the end of each stroke.
2. Lay the needle on the floating cork in the bowl.
3. Let it settle. Then turn it gently and let it settle again.
4. Check the direction with a real compass.

Trial	Direction the needle settles	Same as a real compass?
1		
2		
3		

What it shows: Stroking makes the needle a weak magnet. The Earth behaves like a giant magnet, so the floating needle turns to point roughly north and south.

SAFETY

Needles are sharp. Hold the eye end and store the needle in a matchbox afterwards.

Electricity makes magnetism

Experiment 12: Oersted's experiment

In 1820 the Danish scientist Hans Christian Ørsted noticed that a compass needle moved when a current flowed in a nearby wire. This was the first proof that electricity and magnetism are linked.

You need: a compass, two cells in a holder, a bulb in a holder, a paper clip switch, long wires.

Steps:

1. Lay the compass flat and let the needle settle north-south.
2. Tape a straight part of the wire across the top of the compass, along the same north-south line as the needle.
3. Join the wire in series with the cells, the bulb and the switch. The bulb limits the current and shows you when it flows.
4. Close the switch and watch the needle. Open it again.
5. Swap the two wires on the cell holder and repeat. Then try the wire under the compass.
6. Wind five turns of wire around the compass and repeat.

Set-up	Which way does the needle swing?	Small or large swing?
Wire above, current one way		
Wire above, current reversed		
Wire below the compass		
Five turns round the compass		

What it shows: A current makes a magnetic field around the wire, which pushes the needle. Reversing the current reverses the swing. More turns give a stronger field.

Experiment 13: Electromagnet strength and number of turns

Aim: To find how the number of turns affects an electromagnet's strength.

You need: a large iron nail, 3 m of thin enamelled copper wire, one cell in a holder, a switch, a dish of steel pins.

Steps:

1. Sand 2 cm of coating off both ends of the wire.
2. Wind 10 neat turns on the nail, all in the same direction. Leave the rest of the wire loosely coiled beside it, off the nail.
3. Join the wire ends to the cell through the switch.
4. Close the switch, dip the nail's tip into the pins, lift it, and count the pins. Open the switch.
5. Repeat three times. Then rewind with 20, 30, 40 and 50 turns.

Number of turns	Trial 1	Trial 2	Trial 3	Average
10				
20				
30				
40				
50				

What it shows: More turns make a stronger electromagnet. Using the same length of wire every time keeps the current the same, so the number of turns is the only thing that changes. This is a **fair test**.

Going further: keep 50 turns and change something else, one thing at a time.

Change	Pins picked up
50 turns, one cell	
50 turns, two cells in series	
50 turns, nail pulled out of the coil	

With two cells, more current flows and the magnet is stronger. Without the nail, the coil still makes a field, but it picks up very few pins: the iron core makes the field many times stronger. Switch off and the nail drops the pins, which is what makes an electromagnet so useful. Cranes in scrapyards use giant electromagnets to lift and drop iron.

EXAMPLE

Aditi in Bhopal counted 6, 8 and 7 pins with 30 turns. Her average was $(6 + 8 + 7) \div 3 = 7$ pins.

SAFETY

The coil is almost a short circuit. Close the switch for no more than five seconds at a time. If the cell feels warm, let it rest.

CHAPTER 7

A simple electric motor

Experiment 14: Build a motor that spins

An electric **motor** changes electrical energy into movement. This tiny one needs only a cell, a magnet and some wire.

You need: one D cell, about 1 m of thin enamelled copper wire, two large safety pins, a thick rubber band, a strong round ceramic magnet, sandpaper.

Steps:

1. Wind the wire about 15 times round an AA cell to make a neat ring. Slide it off.
2. Wrap each free end twice round the ring to hold it, leaving 4 cm of straight wire sticking out on opposite sides. These are the axles.
3. Sand all the coating off one axle.
4. Hold the ring upright like a wheel. Sand the coating off only the top half of the other axle.
5. Lay the cell on its side. Hold a safety pin against each end with the rubber band, the eyes of the pins at the top.
6. Put the magnet on top of the cell, in the middle, just under where the coil will sit.

7. Rest the axles in the eyes of the pins and give the coil a gentle push.

Change	What happens to the spin?
As built	
Magnet turned over	
Cell turned round	
Two magnets stacked	
Both axles fully sanded	

What it shows: When current flows through the coil, the magnet's field pushes on it and it turns. The half-sanded axle switches the current off for half of every turn, so the coil is not pushed backwards and keeps spinning. Turning the magnet or the cell round reverses the push, so the motor spins the other way. Fans, mixers and toy cars all use motors that work on this idea.

Your motor and a real motor

Part of your motor	Part of a real motor	Its job
Coil of enamelled wire	Armature (many coils on an iron core)	Carries the current that is pushed round
Ceramic magnet	Field magnets	Provide the magnetic field
Half-sanded axle	Commutator	Switches or reverses the current at the right moment in each turn
Safety pins	Brushes	Carry current into the turning coil

SAFETY

The coil is almost a short circuit, so the cell and the safety pins get warm while the motor runs, and hot if the coil stops on its sanded half. Run it for short spells, lift the coil off whenever it stops, and let the cell cool.

TIP

If the coil will not spin, check that it is balanced, that the sanding is clean, and that the axles are straight and level.

CHAPTER 8

Electricity from a lemon

Experiment 15: A lemon battery that lights an LED

Aim: To make electricity from fruit and use it to light an LED.

You need: four lemons, four pieces of thick copper wire (about 5 cm, cleaned with sandpaper), four galvanised nails, crocodile clip leads, a red LED, a multimeter if you have one.

Steps:

1. Roll each lemon firmly on the table to loosen the juice inside.
2. Push a copper wire and a nail into one lemon, about 2 cm apart. They must not touch.
3. Measure the voltage between them with the meter.
4. Join a second lemon in series: the copper of one to the nail of the next. Measure again. Add the third and the fourth.
5. Join the free copper end to the LED's long leg and the free nail to its short leg. No resistor is needed here, because lemon cells give only a tiny current. Look at the LED in a dark room.

Number of lemons	Voltage	Does the LED glow?
1		
2		
3		
4		

What it shows: Two different metals in an acid juice make a simple **electric cell**. A galvanised nail is iron with a thin coat of zinc, and it is the zinc that matters here. The juice is called the **electrolyte**. Chemical energy changes into electrical energy. One lemon gives a little under 1 V, and the current is very small, so you usually need three or four lemons in series to make an LED glow faintly. A torch bulb needs far more current and will not light at all.

REMEMBER

The copper is the + side and the zinc-coated nail is the – side. If the LED stays dark, check this first.

EXAMPLE

Meera in Nagpur measured 0.9 V, 1.8 V, 2.6 V and 3.5 V with one to four lemons. The LED glowed faintly with three lemons and a little better with four. Each lemon added a little under 1 V, just as expected for cells in series.

TRY THIS

Use potatoes, tomatoes or a cup of salty water instead of lemons. Which gives the highest voltage per piece?

CHAPTER 9

The heating effect and fuses

When current flows through a wire, the wire gets warm. This is the **heating effect** of current. A thin wire that resists the current strongly gets much hotter than a thick copper wire.

Experiment 16: Feel the heating effect safely

You need: two cells in a holder, a 2.5 V bulb in a holder, a switch, a thermometer.

Steps:

1. Note the room temperature on the thermometer.
2. Tape the thermometer's bulb against the glass of the torch bulb.

3. Close the switch. Read the thermometer every minute for five minutes.
4. Open the switch and read it for three more minutes.

Time (minutes)	Temperature, switch on	Time after switching off	Temperature
0		1	
1		2	
2		3	
3			
4			
5			

What it shows: The temperature rises while current flows and falls after you switch off. The filament gets so hot that it glows, and some of that heat warms the glass. An electric iron, a room heater and a geyser all use the heating effect, with coils of a special wire called **nichrome**. An LED gives the same light with far less heat, which is why LED bulbs use less electricity.

How a fuse protects a house

A **fuse** is a short piece of thin wire that melts at a fairly low temperature. It is placed in the circuit that feeds the house wiring. If too much current flows, because of a short circuit or too many appliances on one line, the fuse wire heats up and melts first. The circuit breaks before the house wires can overheat and start a fire.

Most new homes use an **MCB** (miniature circuit breaker) instead. It does the same job, but it switches itself off and can be switched on again once the fault is fixed.

SAFETY

Never replace a fuse wire with a thicker wire, and never touch a fuse box or an MCB box yourself. That is an electrician's job.

DID YOU KNOW

The cell got warm in the electromagnet and motor experiments. That was the heating effect too.

Static electricity

Rubbing two materials together can move tiny charged particles called **electrons** from one to the other. The object that gains electrons becomes negatively charged. The one that loses them becomes positively charged. A charge that stays put on an object is called **static electricity**. Charged objects attract light things, and two objects with the same kind of charge repel.

Experiment 17: The balloon and the paper bits

You need: a balloon, tissue paper torn into small bits, a woollen sweater or scarf.

Steps:

1. Blow up and tie the balloon.
2. Hold it a few centimetres above the paper bits. Note what happens.
3. Rub it 10 times on the wool. Hold it above the bits again.
4. Try 20 rubs, then try rubbing on cotton cloth and on your dry hair.

Rubbed on	Number of rubs	Height at which bits jump up	Number of bits picked up
Not rubbed	0		
Wool	10		
Wool	20		
Cotton	20		
Dry hair	20		

What it shows: Rubbing charges the balloon, and more rubbing gives more charge, so the bits jump from further away. The paper itself is not charged, but the balloon's charge pulls on the charges inside each bit and draws it close. Wool and hair usually charge a balloon far better than cotton.

Experiment 18: Bending water and repelling balloons

You need: two balloons, a woollen sweater, thread, a tap.

Steps:

1. Open a tap to make a very thin, steady stream.
2. Rub the balloon on wool and bring it close to the stream without touching. Watch the stream.
3. Rub two balloons, hang each from a thread, and bring them close together.

Test	What you see
Charged balloon near a thin stream of water	
Two charged balloons brought together	
Charged balloon held against a wall	

What it shows: The charged balloon pulls on the stream of water, just as it pulled on the paper bits, and it can even cling to a wall. Two balloons rubbed on the same material get the same kind of charge, so they push each other apart.

TRY THIS

Rub a plastic comb through dry hair and hold it near the paper bits. Does a comb work as well as a balloon?

REMEMBER

Static experiments work best on dry days. In humid monsoon weather the charge leaks away into the damp air.

DID YOU KNOW

Lightning is a giant spark of static electricity between clouds, or between a cloud and the ground. In a thunderstorm, stay indoors and never shelter under a lone tree.

Practice questions

1. What is the highest battery voltage allowed for the experiments in this book, and what must you never use?
2. What is a short circuit, and why is it dangerous?
3. What is the difference between an open circuit and a closed circuit?
4. Name three conductors and three insulators.
5. Is pencil lead a conductor or an insulator? What is it made of?
6. Two bulbs are joined in series. What happens to the second bulb if the first is removed?
7. Why is the wiring in a house joined in parallel?
8. Two 1.5 V cells are joined + to -. What is the total voltage? What if one is turned round?
9. How does a two-way staircase switch let you control one light from two places?
10. What is the job of the foil cone in a torch?
11. Name two metals that a magnet attracts and two that it does not.
12. What happens when two N poles are brought together?
13. Where are magnetic field lines most crowded around a bar magnet, and what does that tell you?
14. How do you turn a sewing needle into a compass?
15. What did Ørsted discover in 1820?
16. In the electromagnet experiment, why is the same length of wire used every time?
17. Why is only half of one axle sanded in the simple motor?
18. Give two ways to make the simple motor spin the other way.
19. Why do you need three or four lemons to light an LED?
20. In a lemon cell, which metal is the + side?

- 21.** What is the heating effect of current? Give two appliances that use it.
- 22.** How does a fuse protect a house?
- 23.** Why do static electricity experiments work poorly in the monsoon?

ANSWER KEY

Answers

- 1.** 9 V. Never use a wall socket, an extension board, an inverter or a mains adapter.
- 2.** A short circuit is when + and – are joined by a wire with nothing else in the path. A very large current flows, so the wire and cell get hot and the cell may leak.
- 3.** An open circuit has a gap, so no current flows. A closed circuit is a complete path, so current flows.
- 4.** Conductors: copper, aluminium, steel (also graphite). Insulators: plastic, rubber, dry wood (also glass, cloth).
- 5.** A conductor. It is made of graphite, a form of carbon.
- 6.** It goes out too, because the only path for the current is broken.
- 7.** So that each appliance gets the full voltage and can be switched on and off by itself.
- 8.** 3 V. If one is turned round, the two cancel out and the total is 0 V.
- 9.** Each switch can connect to either of two wires that run between them. The bulb lights when both switches choose the same wire, so changing either switch turns it on or off.
- 10.** It reflects the light forward into a narrow, bright beam.
- 11.** Attracted: iron and nickel (also cobalt).
Not attracted: copper and aluminium.
- 12.** They repel, because like poles push each other apart.
- 13.** Near the poles. It shows that the magnetic field is strongest there.
- 14.** Stroke it about 40 times in one direction with one pole of a magnet, then float it on cork in water. It settles pointing north and south.
- 15.** That a current flowing in a wire makes a nearby compass needle move, which showed that electricity and magnetism are linked.
- 16.** So that the current stays the same and the number of turns is the only thing that changes; this makes it a fair test.

17. It switches the current off for half of each turn, so the coil is not pushed backwards and keeps spinning.
18. Turn the magnet over, or turn the cell round.
19. One lemon gives a little under 1 V and a very small current. An LED needs about 2 V, so several lemons must be joined in series.
20. The copper.
21. The warming of a wire when current flows through it. An electric iron and a room heater (also a geyser, a kettle).
22. If too much current flows, the thin fuse wire heats and melts, breaking the circuit before the house wires overheat.
23. The air is damp, and the charge leaks away into it.

WORD LIST

Glossary

Circuit

a complete path through which electric current can flow.

Closed circuit

a circuit with no gaps, so current flows.

Compass

a small magnet, free to turn, that points north and south.

Conductor

a material that lets electric current pass through it easily.

Electrolyte

the liquid or paste in a cell through which charge moves between the two metals.

Electromagnet

a coil of wire, usually round an iron core, that becomes a magnet when current flows.

Electron

a tiny particle with a negative charge; moving electrons make an electric current.

Filament

the thin coiled wire inside a bulb that glows when it gets hot.

Fuse

a thin wire that melts and breaks a circuit when too much current flows.

Heating effect

the warming of a wire when current flows through it.

Insulator

a material that does not let electric current pass through it.

LED (light emitting diode)

a small part that gives light when current flows through it in one direction.

Magnetic field

the space around a magnet where its push or pull can be felt.

MCB (miniature circuit breaker)

a switch that turns itself off when too much current flows, and can be reset.

Motor

a machine that changes electrical energy into movement.

Open circuit

a circuit with a gap, so no current flows.

Parallel

joined so that each part has its own path to the cell.

Pole

one of the two ends of a magnet, where its pull is strongest.

Reflector

a shiny surface that bounces light in one direction.

Series

joined one after another in a single path.

Short circuit

a path that joins + and – with almost no resistance, so a very large current flows.

Static electricity

electric charge that stays on an object instead of flowing.

Switch

a device that opens or closes a gap in a circuit.



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