●●○○○ **Level 2 · Science** S2.8

Magnets and simple circuits

What magnets pull, and how a cell lights a bulb.

Test what magnets attract, find their poles, make a compass, then build a safe circuit with a cell, wires and a bulb, and draw it with symbols.

YOU ARE READY FOR THIS BOOK IF

You can say what a torch needs to give light.

One step up S3.10 Electricity and magnetism

This book **S2.8 Magnets and simple circuits**

Contents

S2.8.1 What magnets pull

S2.8.2 North and south poles

S2.8.3 Magnetic force through things

S2.8.4 Making a compass

S2.8.5 Electricity: safe and unsafe

S2.8.6 A simple circuit

S2.8.7 Conductors, insulators and switches

S2.8.8 Circuit drawings

Key words, A to Z

Written and drawn by attnom. Free to read, print and share.

S2.8.1 CHAPTER 1

What magnets pull

What does a magnet pull?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Every metal thing.
- ☐ **B** Only some things, like iron and steel.
- ☐ **C** Everything, if the magnet is strong.

BY THE END YOU CAN

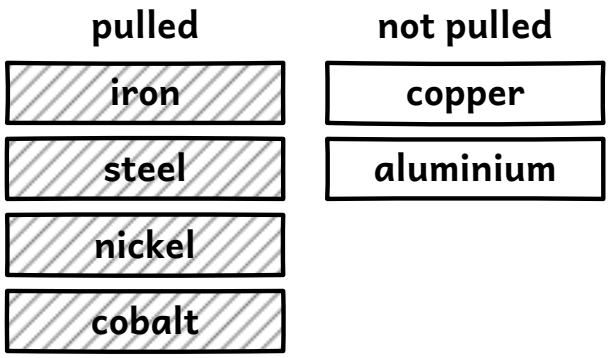
- Test which objects a magnet pulls and which it does not
- Explain that magnets attract iron and steel but not copper or aluminium

A small magnet may stick to a metal door. Does it stick to everything?

A **magnet** is a thing that pulls some other things toward it. To **attract** means to pull close.

A thing that a magnet pulls is **magnetic**. Iron is magnetic. Steel is magnetic. Steel is iron mixed with other things.

Most nails and paper clips are iron or steel. A magnet pulls them. Two other metals, nickel and cobalt, are magnetic too.



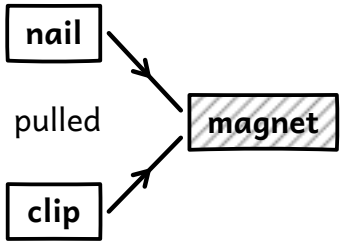
The shaded metals are pulled. The plain ones are not.

DRAW IT FIRST

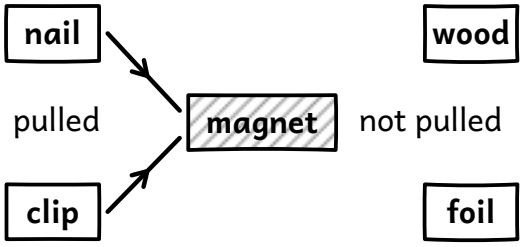
Draw what a magnet pulls



1 Draw a magnet in the middle. Write magnet.



2 On the left, draw a nail and a clip. Draw arrows to the magnet. Write pulled.



3 On the right, draw wood and foil. Draw no arrows. Write not pulled.

A magnet does not pull wood, paper, plastic or cloth. It does not pull glass.

Some metals are not magnetic. Copper is not. Aluminium is not. Cooking foil is aluminium. A magnet does not pull it.

SEE IT THREE WAYS

As a picture

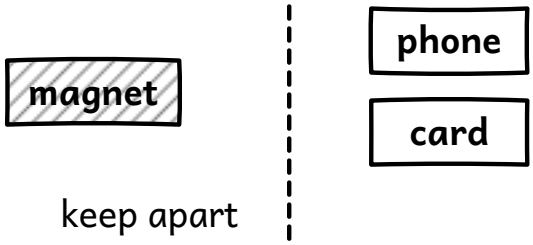
iron	pulled
steel	pulled
copper	not pulled
aluminium	not pulled

In words

A magnet pulls iron and steel. It does not pull copper or aluminium. All four are metals.

To test a thing, hold a magnet close to it. If the thing jumps to the magnet or sticks, it is magnetic.

Be safe. Keep magnets away from phones and bank cards. They can be harmed. Never put a small magnet in your mouth. It can be swallowed.



Keep a magnet apart from a phone and a card.

TRY IT

Which things does a magnet pull?

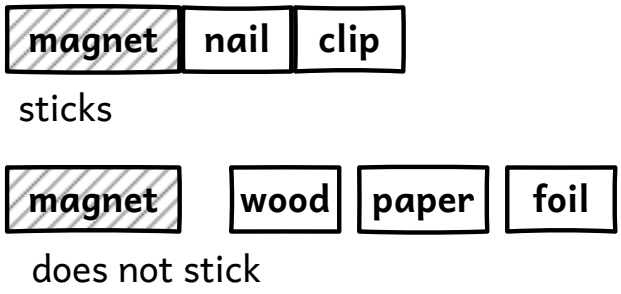
You need: a magnet, or a fridge magnet, a nail, a paper clip, a piece of wood, a piece of paper, a piece of cooking foil, a cloth.

Be safe: Keep the magnet away from phones and bank cards. Never put a magnet or a nail in your mouth. If you have no magnet, look at the result picture.

1. Put the things in a row on a table.
2. Hold the magnet close to the first thing. Does it jump or stick?
3. Test each thing in turn.
4. Sort them into two piles: pulled and not pulled.

What you will see: The nail and the clip stick to the magnet. The wood, paper, foil and cloth do not. Foil is metal, but it is not pulled. A few steel things, such as some pots, may not be pulled. Test each one.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~A magnet pulls all metals.~~

Why it feels right: Nails, pins and clips are metal, and a magnet pulls them.

The test that breaks it: Find cooking foil or a piece of copper wire. Both are metal. Hold the magnet close to each one. Nothing moves. Now hold it to a nail. The nail jumps.

What is true: A magnet pulls iron and steel. It does not pull copper or aluminium, even though they are metals.

KEY WORDS

magnet
a thing that pulls iron and steel toward it.

attract
to pull close.

magnetic
pulled by a magnet.

BACK TO YOUR GUESS

The answer is B: Only some things, like iron and steel.

A magnet pulls iron and steel. It does not pull wood, paper or plastic. It does not pull every metal.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Which of these will a magnet pull?

   A A wooden spoon

   B A copper wire

   C A steel paper clip

   Answer at the back of the book.

2. Amina says a magnet pulls every metal. Is she right?

   A No. It does not pull copper or aluminium.

   B Yes. Any metal sticks to a magnet.

   C Yes, if the magnet is big enough.

   Answer at the back of the book.

3. Which pair will a magnet not pull?

   A An iron nail and a steel clip

   B Copper wire and aluminium foil

   C A steel nail and a wooden stick

   Answer at the back of the book.

4. What does attract mean?

   A To push away

   B To make hot

   C To pull close

   Answer at the back of the book.

5. Sort these into pulled and not pulled. Iron nail, wooden stick, steel clip, plastic comb, aluminium foil.

   Answer at the back of the book.

6. Look at the picture. Why does the foil stay where it is?



A Foil is not a metal.

B Foil is too light for a magnet.

C The magnet is too weak.

D Foil is aluminium, a metal that is not magnetic.

Answer at the back of the book.

7. Kofi holds a magnet near a thing. The thing jumps to the magnet. What does this show?

A The thing is magnetic. It may be iron or steel.

B The thing is made of any metal.

C The thing must be a magnet too.

Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

A magnet pulls iron and steel. It also pulls nickel and cobalt. It does not pull wood, paper, plastic, copper or aluminium. Not every metal is magnetic.

Draw: A magnet. A nail that sticks to it. A piece of wood that does not. Label them.

S2.8.2 CHAPTER 2

North and south poles

Why do two magnets sometimes push each other away?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Magnets only ever pull.
- ☐ **B** Only very big magnets can push.
- ☐ **C** Magnets pull or push, by which ends meet.

BY THE END YOU CAN

- Show that like poles push apart and unlike poles pull together
- Find the poles of a magnet using a second magnet

Hold two magnets close. Sometimes they jump together. Sometimes they push apart. Why?

A bar magnet has two ends called **poles**. A pole is where the pull is strongest. One pole is called north, or N. The other is called south, or S.

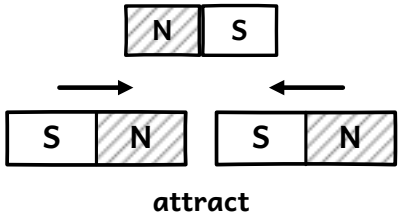
In our pictures, the N half is shaded with lines. The S half is plain.

DRAW IT FIRST

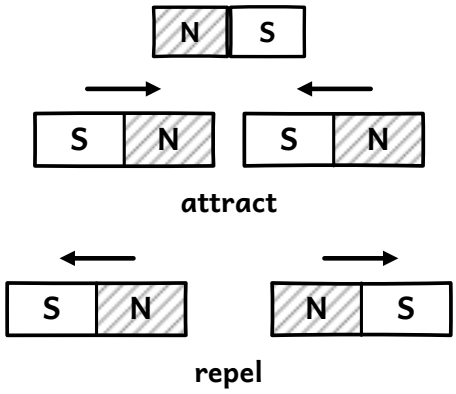
Draw how two magnets act



1 Draw a bar magnet. Write N on one end and S on the other.



2 Draw two magnets with N facing S. Draw arrows toward each other. Write attract.



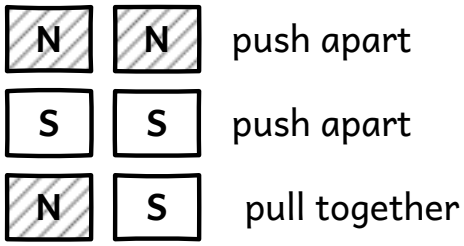
3 Draw two magnets with N facing N. Draw arrows away from each other. Write repel.

Two poles that are the same are like poles. N and N are like. S and S are like. N and S are unlike.

To **repel** means to push away. Like poles repel. Unlike poles attract.

SEE IT THREE WAYS

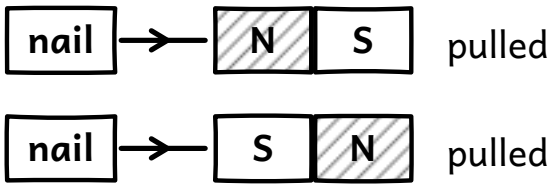
As a picture



In words

Like poles push apart. Unlike poles pull together.

Only a magnet can push a magnet. Either pole pulls an iron nail that is not a magnet. It is never pushed.



A nail that is not a magnet is pulled by either pole.

You can find the poles of a magnet with a second magnet. The poles of the second magnet tell you which is which.

Be safe. Keep magnets away from phones and bank cards. Strong magnets can pinch your fingers. Never put a small magnet in your mouth.

TRY IT

Find the poles with *a* second magnet

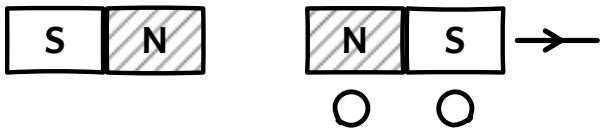
You need: two bar magnets, or two fridge magnets, two round pencils, *a* small piece of tape, *a* smooth table.

Be safe: Keep the magnets away from phones and bank cards. If you have no magnets, look at the result picture.

1. Stick tape on one end of magnet A. Call that end N.
2. Lay magnet B on the two pencils. It can roll.
3. Hold the N end of A near one end of B. Do not touch.
4. Does B roll away, or toward A?
5. Now try the other end of B.

What you will see: One end of B rolls away from the N end of A. That end of B matches your N. The other end of B rolls toward A. It matches your S. Your N is only *a* name you chose. It may really be S. The rule still works. With round fridge magnets, flip one over. One face pulls. The other face pushes.

If you cannot try it, this is what happens.



moves away

A WRONG IDEA MANY PEOPLE HAVE

~~Magnets only pull.~~

Why it feels right: A magnet pulls nails, clips and the fridge door. You never see it push them.

The test that breaks it: Hold two magnets close. Turn one around, so the other end faces the first. Before, they pulled together. Now they push apart.

What is true: Two magnets can pull or push. Only *a* magnet can push *a* magnet. An iron nail that is not *a* magnet is never pushed away.

KEY WORDS

pole
an end of a magnet, where the pull is strongest. N or S.

attract
to pull close. Unlike poles do this.

repel
to push away. Like poles do this.

BACK TO YOUR GUESS

The answer is C: Magnets pull or push, by which ends meet.

Magnets can pull or push. It depends on which ends meet. Like poles push. Unlike poles pull.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Two N poles are held close. What happens?

   A They pull together.

   B They push apart.

   C Nothing happens.

   Answer at the back of the book.

2. Look at the picture. What will the two magnets do?



   A They will pull together.

   B They will push apart.

   C Nothing, because the poles are different.

   Answer at the back of the book.

3. One end of a magnet pulls the N end of another. What pole is that end?

   A N

   B It could be N or S. Both pull an N pole.

   C S

   Answer at the back of the book.

4. **From an earlier chapter**

   Which of these will a magnet pull?

   A A steel nail

   B A wooden stick

   C A piece of cooking foil

   Answer at the back of the book.

5. You have a magnet with N marked. How do you find the poles of a second magnet?

   Answer at the back of the book.

6. Why do two magnets sometimes push each other apart?

   A The N pole always pushes. The S pole always pulls.

   B The bigger magnet pushes the smaller one.

   C Unlike poles face each other.

   D Like poles face each other.

   Answer at the back of the book.

7. Look at the picture. Hana turns one magnet right round. What do they do now?



attract

A They still pull together.

B They push apart.

C They no longer act on each other.

Answer at the back of the book.

8. Look at the picture. A nail that is not a magnet sits by the S end. What does it do?



A It is pushed away.

B Nothing. Only the N pole pulls nails.

C It does not move, because it is not a magnet.

D It is pulled toward the S end.

Answer at the back of the book.

9. Which way finds the poles of a magnet, using a second magnet?

A Hold both ends near an iron nail.

B Find the end that pulls harder.

C Bring a marked N end near each end. The end that is pushed away is N.

Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

A magnet has two poles, N and S. Like poles push apart. Unlike poles pull together. Only a magnet can push another magnet. An iron nail that is not a magnet is only ever pulled.

Draw: Two bar magnets with N and S ends. Arrows to show push and pull.

S2.8.3 CHAPTER 3

Magnetic force through things

Can a magnet pull through paper or water?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Yes. The pull goes through paper, cloth, water and wood.
- ☐ **B** No. A magnet must touch the thing.
- ☐ **C** Only through things you can see through.

BY THE END YOU CAN

- Test if a magnet works through paper, cloth, water and wood
- Compare magnets by counting the pins or clips each one holds

A magnet can pick up a clip without touching it. Can it pull through paper? Through water?

A **force** is a push or a pull. The pull of a magnet is the **magnetic force**.

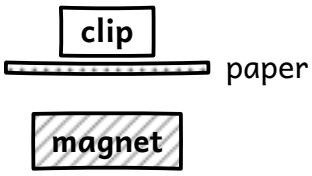
Magnetic force goes through paper. It goes through cloth, water and wood. It goes through air too.

DRAW IT FIRST

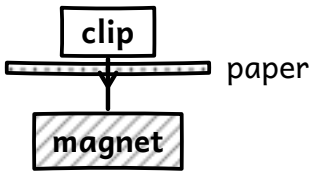
Draw a pull through paper



1 Draw a sheet of paper. Put a clip on top. Write clip and paper.

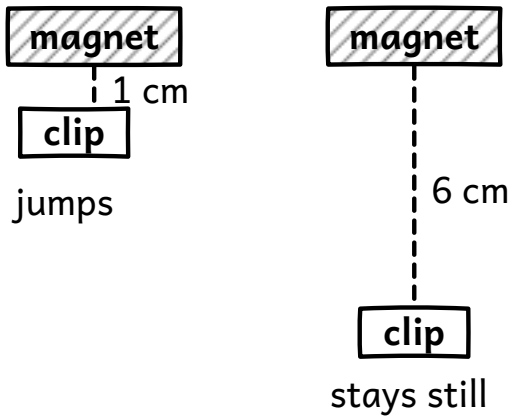


2 Draw a magnet under the paper. Write magnet.



3 Draw an arrow from the clip to the magnet. The pull goes through the paper.

The pull gets weaker as the gap gets wider. A thick pile of cloth keeps the clip far from the magnet. Then the pull can be too weak.



For this magnet, a clip 1 cm away jumps. A clip 6 cm away stays still. A weaker magnet needs a smaller gap.

Some magnets are stronger than others. The **strength** of a magnet is how hard it pulls.

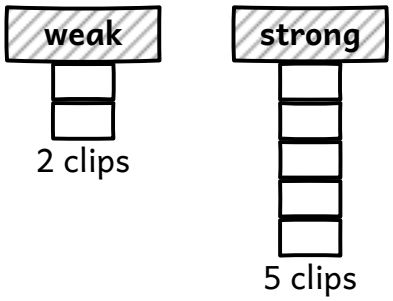
To compare magnets, count the clips each one holds. A stronger magnet holds more clips.

A big magnet is not always strong. A small one can hold more clips. Do not trust the size. Count the clips.

Make it a fair test. Use the same clips each time. Dip each magnet into the same pile.

SEE IT THREE WAYS

As a picture



In words

A strong magnet holds more clips than a weak one. Count the clips to compare.

In symbols

Weak: 2 clips. Strong: 5 clips. 5 is more than 2.

Be safe. Pins are sharp. Use paper clips, or ask a grown up to help with pins. Keep magnets away from phones and bank cards. Never put a small magnet in your mouth.

TRY IT

Does the pull go through?

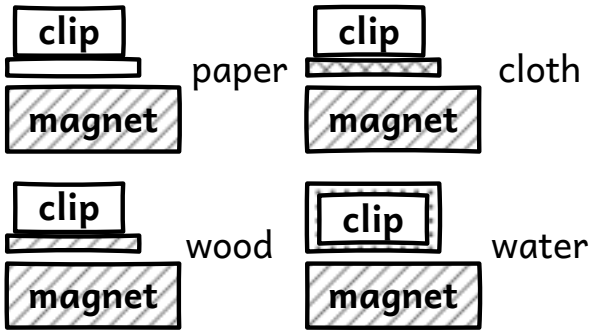
You need: a magnet, a paper clip, a sheet of paper, a piece of cloth, a thin piece of wood, a plastic cup with a little water in it, a second magnet, if you have one.

Be safe: Use a plastic cup, not glass. Keep the magnets away from phones and bank cards. If you have no magnet, look at the result picture.

1. Lay the clip on the paper. Hold the magnet under the paper.
2. Move the magnet. Does the clip follow?
3. Do the same with the cloth and with the wood.
4. Put the clip in the cup of water. Hold the magnet under the cup.
5. Dip each magnet into a pile of clips. Count the clips each one holds.

What you will see: The clip follows the magnet through the paper. It does the same through the cloth, the wood and the water. The magnet does not need to touch it. Thick wood may make the gap too wide. With two magnets, the one that holds more clips is stronger.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~A magnet works only when it touches something.~~

Why it feels right: A magnet sticks to a nail when they touch.

The test that breaks it: Lay a clip on a table. Slowly bring a magnet close. Do not touch it. The clip jumps to the magnet from a little way off. Now lay paper over the clip. Hold the magnet over the paper. The clip still comes up.

What is true: A magnet pulls across a gap. The pull goes through paper, cloth, water and wood. It gets weaker as the gap grows.

KEY WORDS

force
a push or a pull.

magnetic force
the pull of a magnet. It goes through paper, cloth, water and wood.

strength
how hard a magnet pulls. Count clips to compare.

BACK TO YOUR GUESS

The answer is A: Yes. The pull goes through paper, cloth, water and wood.

The pull goes through paper, cloth, water and wood. It gets weaker as the gap gets wider.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. A clip is in a cup of water. A magnet is held at the side of the cup. What happens?

   A Nothing. Water stops a magnet.

   B The clip floats away from the magnet.

   C The clip moves toward the magnet.

   Answer at the back of the book.

2. Magnet A holds 3 clips. Magnet B holds 7 clips. How many more clips does B hold?

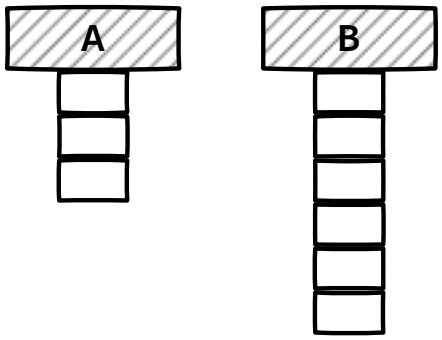
   A 10 more

   B 4 more

   C 7 more

   Answer at the back of the book.

3. Look at the picture. Which magnet is stronger?



   A A

   B B

   C They are the same.

   Answer at the back of the book.

4. Does a magnet have to touch a clip to pull it?

   A No. The pull works across a gap.

   B Yes. It only works by touching.

   C Only if the magnet is very strong.

   Answer at the back of the book.

5. **From an earlier chapter**

   Two S poles are held close. What happens?

   A They pull together.

   B Nothing happens.

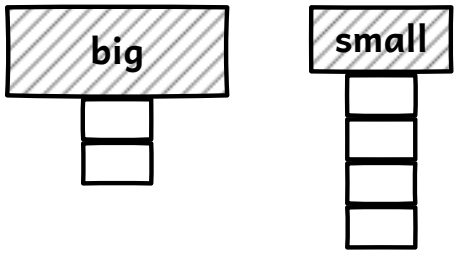
   C They push apart.

   Answer at the back of the book.

6. How would you test if a magnet pulls through a cloth?

   Answer at the back of the book.

7. Look at the picture. One magnet is big and one is small. Which is stronger?



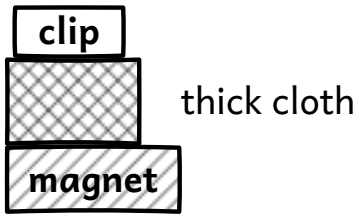
   A The big one, because it is bigger.

   B They are the same, because they are both magnets.

   C The small one, because it holds more clips.

   Answer at the back of the book.

8. Look at the picture. A magnet is under a thick pile of cloth. The clip does not move. Why?



   A The gap is wide, so the pull is too weak.

   B Cloth stops all magnetic force.

   C The magnet works only if it touches the clip.

   Answer at the back of the book.

9. Tariq wants a fair test of two magnets. What should he do?

   A Use big clips for one magnet and small clips for the other.

   B Dip the magnet that looks strongest more than once.

   C Pick the magnet that looks strongest.

   D Dip each magnet into the same pile of the same clips.

   Answer at the back of the book.

10. Which things let the pull of a magnet go through?

    A Only clear things, like glass and water.

    B Only paper. Water and wood stop it.

    C Nothing. A magnet must touch the clip.

    D Paper, cloth, water and wood.

    Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

The pull of a magnet goes through paper, cloth, water and wood. It gets weaker as the gap grows. A stronger magnet holds more clips. Count the clips to compare.

Draw: A clip on paper. A magnet under it. An arrow between them.

S2.8.4 CHAPTER 4

Making a compass

How does a compass know where north is?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** It looks for the Sun.
- ☐ **B** Someone has to set it by hand.
- ☐ **C** A small magnet inside it turns to point north and south.

BY THE END YOU CAN

- Make a compass from a magnetised needle floating on water
- Explain that a compass needle points north and south

A **compass** is a tool that shows you which way is north. Inside it is a thin magnet that can turn.

You can make one. First you must **magnetise** a needle. This means to make it a magnet.

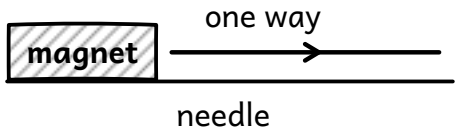
Stroke the needle with one end of a magnet. Stroke it many times. Always stroke the same way. Lift the magnet away at the end of each stroke.

Be safe. A needle is sharp. A grown up must hold it and help you. Keep magnets away from phones and bank cards.

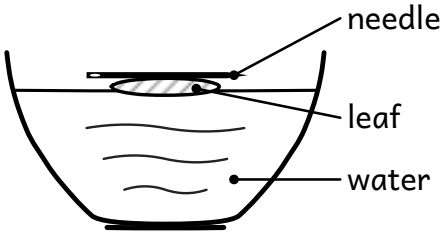
Next, float the needle. Lay it on a leaf or paper. Float that on still water. The leaf holds it up. The needle can turn freely.

DRAW IT FIRST

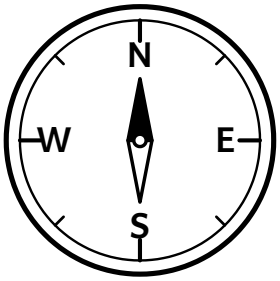
Draw how to make a compass



1 Draw a magnet sliding along a needle, one way. Write magnet, needle and one way.



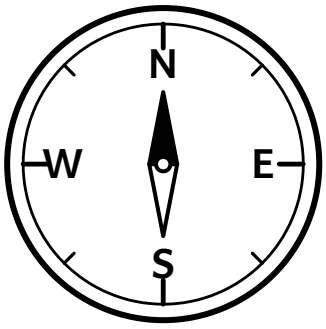
2 Draw the needle on a leaf on water. Write needle, leaf and water.



3 Draw a circle with N, E, S and W. Draw the needle inside it.

Wait. The needle turns slowly. Then it stops. One end points north. The other end points south.

In our pictures, the black half points north, to N. The white half points south, to S. On a real compass the north end may be red.



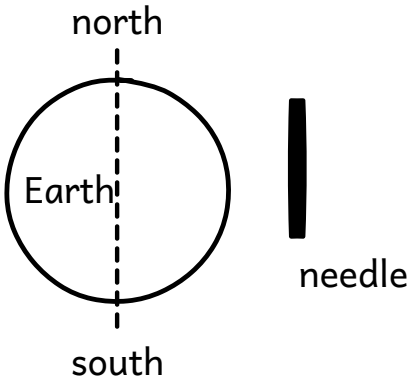
The black half points north, to N. The white half points south, to S.

Why? The Earth acts like a giant magnet. The needle is a small magnet. It lines up with the Earth.

The needle points roughly north and south. In many places it is a little off true north. It is still near enough to find your way.

SEE IT THREE WAYS

As a picture



In words

The Earth acts like a giant magnet. A needle lines up with it. One end points north. The other end points south.

A compass works in most places on Earth. Turn round, and the needle still points the same way.

TRY IT

Make a compass

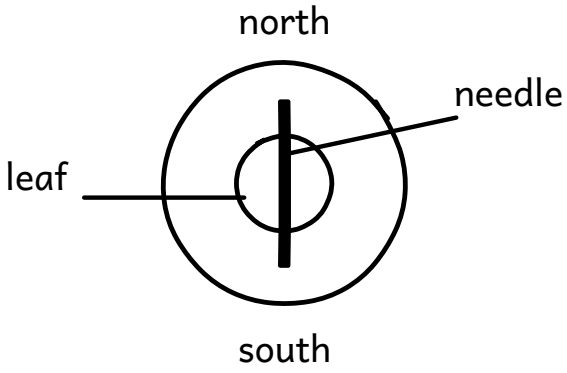
You need: a sewing needle, a magnet, a leaf or a scrap of paper, a bowl of still water, a grown up to help.

Be safe: A needle is sharp. A grown up must help. Never put a needle or magnet in your mouth. If you have no needle or magnet, look at the result picture.

1. A grown up holds the needle. Put one end of the magnet at the eye of the needle.
2. Slide the magnet along to the point. Lift it away. Go back through the air.
3. Do this about 30 times. Always the same way.
4. Set the bowl where there is no wind. Wait until the water is still.
5. Lay the leaf on the water. Lay the needle on the leaf.
6. Wait. Watch the needle turn, then stop.
7. Turn the bowl. The needle turns back the same way.

What you will see: The needle turns and stops. It points roughly north and south. Turn the bowl and it stops the same way again. One end always points north. Ask a grown up which way north is. Mark that end with a dot. If it does not turn, stroke it more times. Keep other magnets and phones away.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~A compass needle always points north, whatever is near it.~~

Why it feels right: On a walk, a compass shows north every time you look.

The test that breaks it: Float your needle, or lay a compass on a table. Wait until it is still. Now bring a magnet close. The needle turns toward the magnet. Take the magnet away. The needle turns back.

What is true: The Earth pulls the needle only a little. A magnet that is near pulls much harder. Keep a compass away from magnets.

KEY WORDS

compass
a tool with a magnet needle that points north and south.

magnetise
to make a thing into a magnet.

needle
a thin piece of steel. Floating, it turns to point north and south.

BACK TO YOUR GUESS

The answer is C: A small magnet inside it turns to point north and south.

A compass has a small magnet that can turn. The Earth acts like a giant magnet. The needle lines up with it.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. How do you magnetise a needle?

   A Rub it backwards and forwards with a magnet.

   B Stroke it many times one way with a magnet.

   C Put it in water.

   Answer at the back of the book.

2. A needle floats on a leaf and stops. Which way does it point?

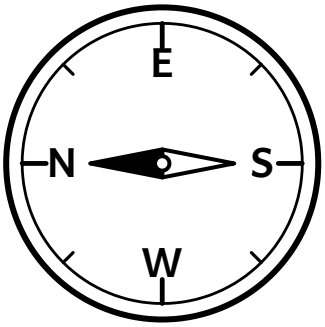
   A Roughly north and south

   B Toward the nearest wall

   C Toward the Sun

   Answer at the back of the book.

3. Look at the picture. Which letter does the black half of the needle point to?



   A E

   B S

   C W

   D N

   Answer at the back of the book.

4. Why does a floating needle turn?

   A The water pushes it north.

   B The leaf steers it.

   C A small wind turns it.

   D The Earth acts like a giant magnet.

   Answer at the back of the book.

5. **From an earlier chapter**

   Which of these will a magnet pull?

   A A wooden stick

   B A steel needle

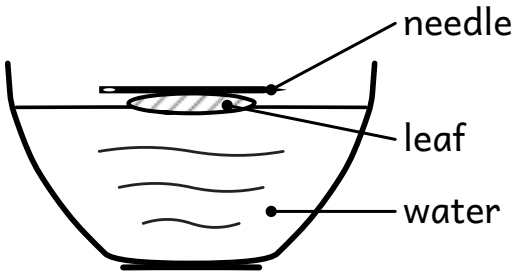
   C A plastic comb

   Answer at the back of the book.

6. Write the steps to make a compass.

   Answer at the back of the book.

7. Look at the picture. Why does the needle lie on a leaf?



   A The leaf holds it up, so it can turn freely.

   B The leaf makes it a magnet.

   C The leaf stops it turning.

   Answer at the back of the book.

8. Ravi turns the bowl round. What does the floating needle do?

   A It turns with the bowl and keeps its place on the leaf.

   B It stops pointing anywhere.

   C It turns back and again points roughly north and south.

   Answer at the back of the book.

9. A compass is set down next to a strong magnet. What does the needle do?

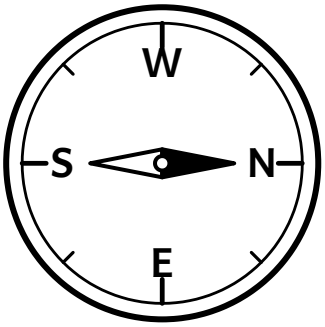
   A It still points north.

   B It turns toward the magnet.

   C It is broken for ever.

   Answer at the back of the book.

10. Look at the picture. The dial is turned round. Which half of the needle points north?



   A The white half.

   B Either half. It depends how you hold the dial.

   C The black half.

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Stroke a needle many times one way with a magnet. Float it on a leaf on still water. It turns to point roughly north and south. The Earth acts like a giant magnet.

Draw: A bowl of water. A leaf with a needle on it. The words north and south.

S2.8.5 CHAPTER 5

Electricity: safe and unsafe

Why can I hold a cell but not touch a wall socket?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Both are the same, so both are safe.
- ☐ **B** A torch cell is safe. Mains electricity can kill.
- ☐ **C** A wall socket is safe if my hands are dry.

BY THE END YOU CAN

- Name things at home that use cells and things that use mains
- Explain why we never experiment with wall sockets or mains wires

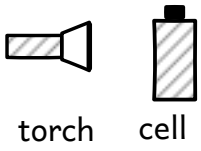
Electricity makes a torch shine and a fan turn. It comes from two kinds of place.

One place is a **cell**. A cell makes electricity from the chemicals inside it. Many people call a cell a battery. Torches, clocks and toys use cells.

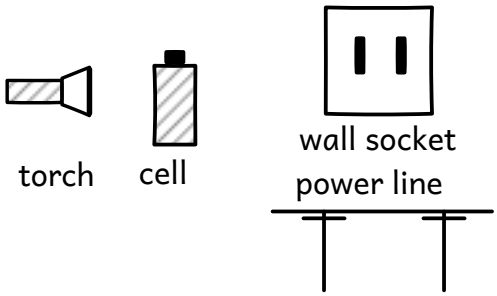
The other place is the **mains**. The mains is electricity sent to buildings along wires. It comes out of wall sockets. It also runs along power lines.

DRAW IT FIRST

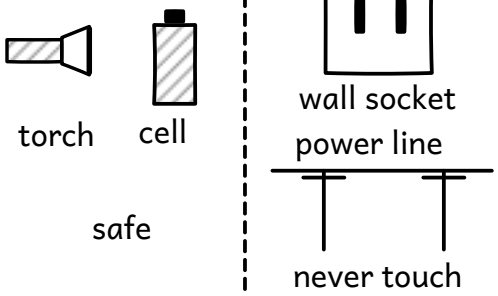
Draw the two kinds of electricity



1 Draw a torch and a cell. Write torch and cell.



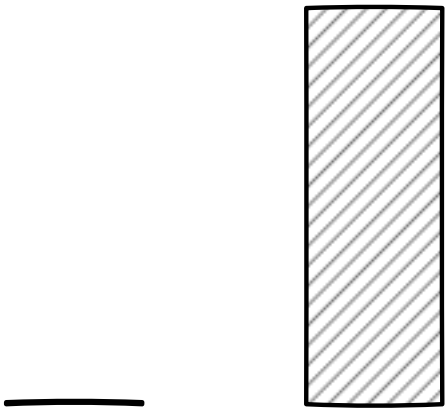
2 Draw a wall socket and a power line. Write wall socket and power line.



3 Draw a dashed line between them. Write safe on the left and never touch on the right.

A torch cell is small and gentle. It is safe to use in a circuit. The label says 1.5 V. The V is for volts. Volts tell you how hard electricity pushes.

The mains pushes much harder. It is 100 V or more. Mains electricity can kill.



cell
1.5 V

mains
100 V or more

The bars use the same scale. The mains pushes far harder than a cell.

Be safe. Never push anything into a wall socket. Never touch a plug, a socket or a mains wire. Never go near a wire that fell from a power line. Tell a grown up at once.

Water and the mains are a deadly pair. Never touch a plug, a switch or a wire with wet hands. You will see why in the chapter on conductors.



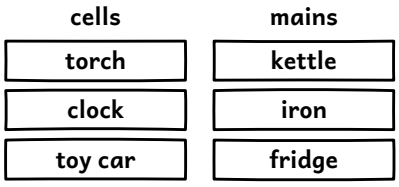
never touch

Wet hands and a plug must never meet.

A generator or a big solar panel can also make strong electricity. Leave its wires alone too.

SEE IT THREE WAYS

As a picture



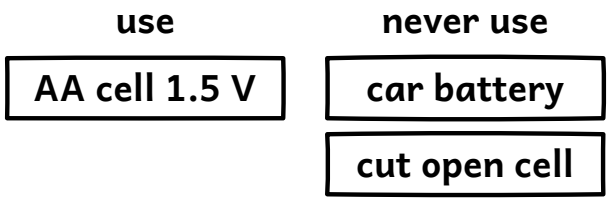
In words

Small things you carry often run on cells. Big things and things that make heat use the mains.

In symbols

A torch cell: 1.5 V.
The mains: 100 V or more.

Be safe. Use only AA or AAA torch cells marked 1.5 V. Never put a cell in your mouth. Keep button cells, the small flat round ones, away from little children. A swallowed one burns inside. Tell a grown up at once. Never use a car battery. It can burn you and it can explode. Never cut open a cell. What is inside can burn your skin and eyes.



Use a small torch cell. Never use a car battery. Never cut a cell open.

TRY IT

Hunt for cells and mains at home

You need: paper and a pencil, a grown up to walk round with you.

Be safe: Look only. Never touch a socket, a plug or a mains wire.

1. Walk round your home with a grown up. Look, but do not touch.
2. Find things that run on cells. Think of a torch, a clock or a toy.
3. Find things that use the mains. Look for a plug and a wire to the wall.
4. Do not touch plugs, sockets or wires. Do not open anything.
5. Make a table with two columns. Write thing and cell or mains.
6. List what you find. If your home has no mains, list the cells you find.

What you will see: Small things you carry often run on cells. Big things and things that make heat use the mains. A phone has a cell inside, but it charges from the mains. If you cannot do this, read the table.

If you cannot try it, this is what happens.

thing	cell or mains
torch	cell
clock	cell
kettle	mains
iron	mains
fan	mains

A WRONG IDEA MANY PEOPLE HAVE

~~A cell and the mains are the same, so both are safe.~~

Why it feels right: Both can light a bulb. A torch and a lamp look alike when they shine.

The test that breaks it: Read the label on a torch cell. It says 1.5 V. Ask a grown up to show you an electric kettle label. It says 100 V or more. Only read the labels. Do not plug anything in.

What is true: The mains pushes at least 60 times harder than a torch cell. A torch cell is safe. The mains can kill.

KEY WORDS

cell
a small thing that makes electricity from chemicals. Many people say battery.

mains
the strong electricity sent to buildings along wires. It can kill.

BACK TO YOUR GUESS

The answer is B: A torch cell is safe. Mains electricity can kill.

A torch cell is safe to use. Mains electricity from a wall socket or a power line can kill. Never touch it.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Which of these runs on a torch cell?

    A An electric kettle

    B An electric iron

    C A pocket torch

    Answer at the back of the book.

2. Why must we never push things into a wall socket?

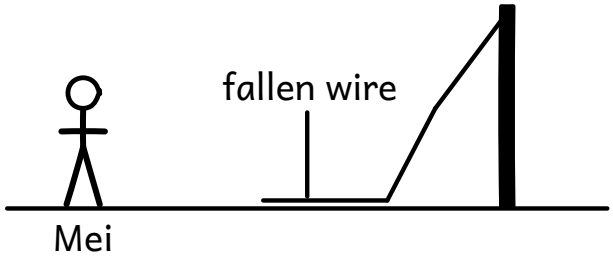
    A Mains electricity can kill.

    B The socket might break.

    C The cell inside would run out.

    Answer at the back of the book.

3. Mei sees a wire on the ground. It fell from a power line. What should she do?



    A Move it with a wooden stick.

    B Pick it up with dry hands.

    C Step over it with care.

    D Stay far away and tell a grown up at once.

    Answer at the back of the book.

4. Which cell is safe for the activities in this book?

    A A small torch cell marked 1.5 V

    B A car battery

    C A cell that you cut open

    Answer at the back of the book.

5. **From an earlier chapter**

   A magnet touches each of these. Which one does it pull?

   A A plastic comb

   B A wooden spoon

   C An iron nail

   Answer at the back of the book.

6. Cell or mains? Sort these: torch, electric kettle, toy car, electric iron.

   Answer at the back of the book.

7. Joseph says a quick touch of a wall socket is safe. Is he right?

   A Yes. A quick touch cannot hurt.

   B Yes, if you wear shoes.

   C Yes, if your hands are dry.

   D No. The mains can kill, even in a moment.

   Answer at the back of the book.

8. Sipho finds a button cell, a small flat round one. His little sister is near. What should he do?

   A Let her hold it while he watches.

   B Keep it away from little children and tell a grown up.

   C Cut it open to see inside.

   Answer at the back of the book.

9. A torch cell is 1.5 V. The mains is 100 V or more. Which is true?

   A Both push about the same, so both are safe.

   B The cell pushes harder, because it is small.

   C The mains pushes far harder, so it can kill.

   D The mains is safe, because it comes from a wall.

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Torch cells are safe to use. Mains electricity from a wall socket or a power line can kill. Never touch sockets, plugs or mains wires. Never use a car battery. Never cut open a cell.

Draw: Two columns. Cell: a torch and a clock. Mains: a kettle and an iron. Cross out the mains.

S2.8.6 CHAPTER 6

A simple circuit

Why will my bulb not light with just one wire?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** One wire from the cell to the bulb is enough.
- ☐ **B** The bulb must be in a full loop with the cell.
- ☐ **C** The cell is too weak to light any bulb.

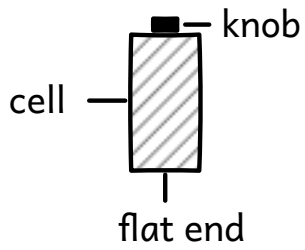
BY THE END YOU CAN

- Build a circuit with a cell, wires and a bulb
- Explain why a circuit must be a complete loop

A torch has a cell and a bulb. Press the switch and the bulb lights.

You can light a bulb with a cell and two wires. But you must join them the right way.

A cell has two ends. One end has a small knob. The other end is flat.

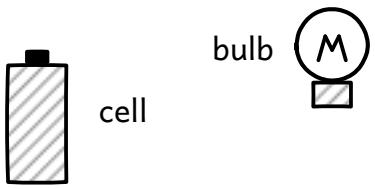


The two ends of a cell.

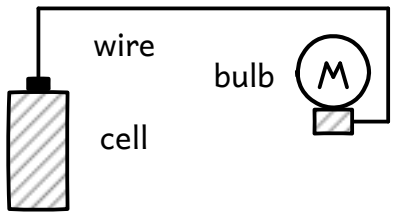
Electricity goes out of one end of the cell. It must come back to the other end.

DRAW IT FIRST

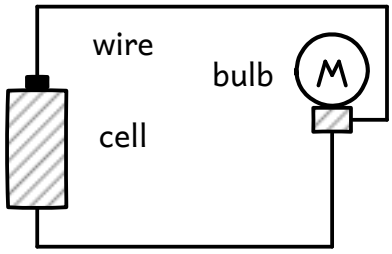
Draw a cell lighting a bulb



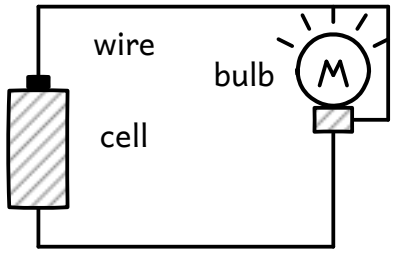
1 Draw a cell and a bulb. Write cell and bulb.



2 Draw a wire from the cell knob to the bulb side. Write wire.



3 Draw a second wire from the flat end to the bulb tip.



4 Draw short lines round the bulb to show it is lit.

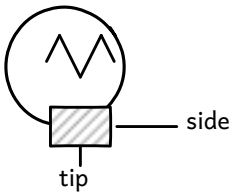
A **circuit** is a path that goes all the way round. It leaves one end of the cell. It goes through the wires and the bulb. It comes back to the other end.

A bulb has two **contact points**. A contact point is a place where a wire must touch. One is the metal side. The other is the tip at the bottom.

Electricity goes in at one contact point. It goes out at the other. On the way it passes through a thin wire inside the bulb. That thin wire glows.

SEE IT THREE WAYS

As a picture



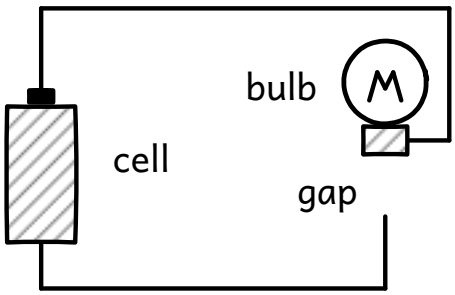
In words

A bulb has two contact points. One is the metal side. The other is the tip. Both must touch wires.

In symbols

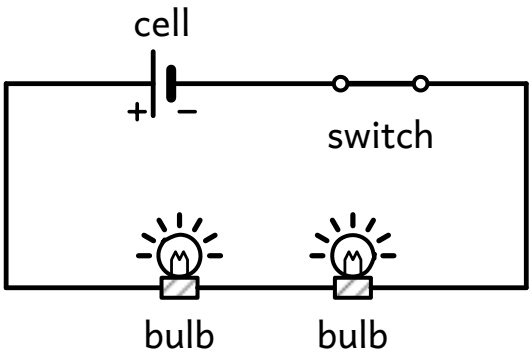
A cell has 2 ends. A bulb has 2 contact points. All 4 must be in the loop.

A circuit must be a complete loop. A ***gap*** is a break in the loop. A gap anywhere stops the electricity. The bulb stays dark.



One wire stops short. The loop has a gap. The bulb is dark.

Put two bulbs in one loop, one after the other. Both light, but each is dimmer than one bulb alone. The first bulb does not use up the electricity. The same electricity goes all the way round.



Two bulbs in one loop. Both light, and each is dim.

Be safe. Use only a torch cell. Never use the mains or a car battery. Never join the two ends of a cell with only a wire. The wire gets hot and the cell goes flat.

TRY IT

Light a bulb with a cell

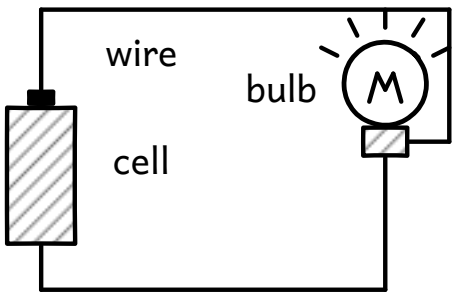
You need: a torch cell marked 1.5 V, a small torch bulb, marked 1.5 V if you can, two strips of kitchen foil, folded long and thin.

Be safe: Never let the two strips touch each other. That joins the two ends of the cell. The foil gets hot fast.

1. Fold each foil strip long and thin. Each is about 15 cm.
2. Hold one strip on the knob end of the cell.
3. Hold the other strip on the flat end of the cell.
4. Touch the first strip to the metal side of the bulb.
5. Touch the other strip to the tip of the bulb. Watch the bulb.
6. Lift the second strip off the tip. What happens?
7. Put the second strip back on the glass, not the tip. What happens?

What you will see: Strips on the side and the tip light the bulb. Lift one strip and the bulb goes out. On the glass it stays dark. The glass is not a contact point. If it stays dark, press harder. Check that the bulb suits the cell. No cell or bulb? Switch a torch on and off. Do not open it. Inside, the cells, the switch and the bulb make one loop. The switch opens a gap in the loop.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~One wire from the cell to the bulb is enough.~~

Why it feels right: A torch seems to have no second wire. The cell seems to send electricity to the bulb.

The test that breaks it: Join one foil strip from the cell knob to the bulb side. The bulb stays dark. Add a second strip from the flat end to the tip. Now it lights. Lift the second strip and it goes out again.

What is true: Electricity must go round a full loop. The bulb needs a wire at each of its two contact points.

KEY WORDS

circuit
a path round from one end of the cell to the other.

contact point
a place where a wire must touch. A bulb has two.

gap
a break in the loop. It stops the electricity.

BACK TO YOUR GUESS

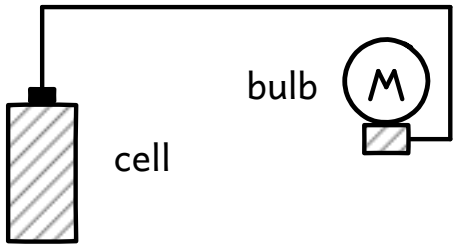
The answer is B: The bulb must be in a full loop with the cell.

The cell, the wires and the bulb must make a full loop. One wire between them leaves a gap, so the bulb stays dark.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Look at the picture. The bulb is dark. What is missing?



A A bigger cell

B A shorter wire

C A second wire, from the flat end to the tip

Answer at the back of the book.

2. Amina has a cell, a bulb and two wires. Which way lights the bulb?

A One wire from the knob to the side. One from the flat end to the tip.

B Both wires from the cell to the tip.

C One wire from the knob to the tip. Nothing on the flat end.

Answer at the back of the book.

3. Ravi puts two bulbs in one loop with one cell. What happens?

A Only the bulb next to the cell lights.

B Both bulbs light, but they are dim.

C Neither bulb lights.

Answer at the back of the book.

4. Why does a bulb stay dark when the loop has a gap?

A The bulb has run out of electricity.

B The wires are too thin.

C The cell is too weak to light it.

D Electricity cannot go all the way round.

Answer at the back of the book.

5. **From an earlier chapter**

   Which of these can kill?

   A A torch cell marked 1.5 V

   B The cell in a clock

   C Mains electricity from a wall socket

   Answer at the back of the book.

6. Draw a cell, a bulb and two wires so the bulb lights. Show where each wire touches.

   Answer at the back of the book.

7. Hana joins a cell to a bulb with two foil strips. One is on the side. The other is on the glass. What happens?

   A The bulb stays dark. The glass is not a contact point.

   B The bulb lights. Any part of the bulb will do.

   C The bulb lights, but it is dim.

   Answer at the back of the book.

8. Which of these is a complete circuit that lights a bulb?

   A A cell, a bulb and one wire from knob to side. Nothing touches the tip.

   B A bulb and two wires, with no cell.

   C A cell and a bulb, with both wires on one contact point.

   D A cell, a bulb and two wires in one full loop.

   Answer at the back of the book.

9. A cell has 2 ends. A bulb has 2 contact points. How many of them must be in the loop?

   A 3

   B 2

   C 4

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

A circuit is a path all the way round. A bulb lights in a complete loop of cell, wires and bulb. A gap stops it. Both contact points of the bulb must be in the loop.

Draw: A cell and a bulb. Two wires make a loop. Draw short lines round the bulb.

S2.8.7 CHAPTER 7

Conductors, insulators and switches

Which things let electricity pass?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Everything lets electricity pass the same way.
- ☐ **B** Only shiny things do.
- ☐ **C** Metals do. Plastic and wood do not.

BY THE END YOU CAN

- Test which materials let electricity pass in a circuit
- Make a switch from paper clips or kitchen foil

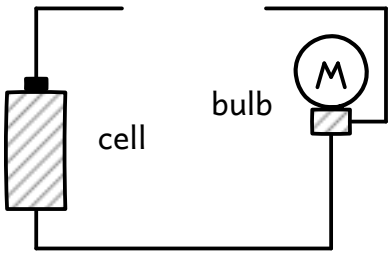
Some materials let electricity pass. Others do not. A circuit can tell you which.

A **conductor** is a material that lets electricity pass. Metals are conductors.

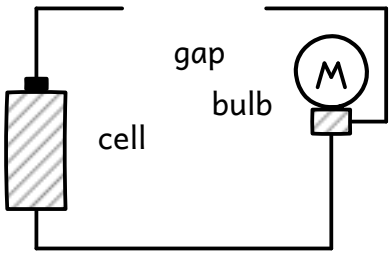
An **insulator** is a material that does not let electricity pass. Plastic, wood, rubber, glass and dry paper are insulators.

DRAW IT FIRST

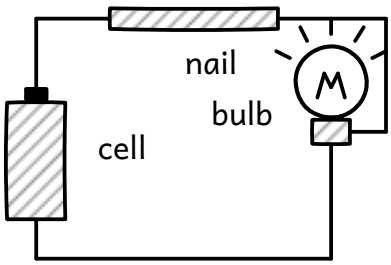
Draw a circuit that tests materials



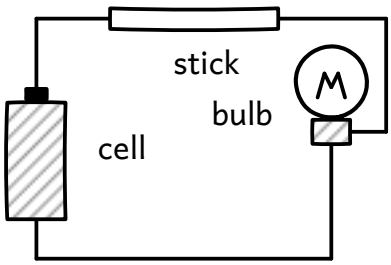
1 Draw a cell, a bulb and wires. Leave a gap in the top wire.



2 Write gap. The bulb is dark.



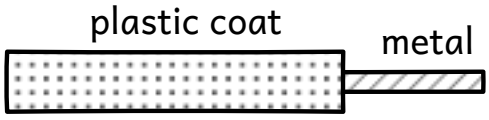
3 Lay a nail across the gap. The bulb lights. Write nail.



4 Swap the nail for a stick. The bulb goes dark. Write stick.

The nail is a conductor. It joins the two ends of the wire. The loop is complete. The stick is an insulator. The gap stays.

Wires have metal inside and plastic outside. The metal carries the electricity. The plastic keeps it in the wire. It keeps you safe too.



Metal inside, plastic outside.

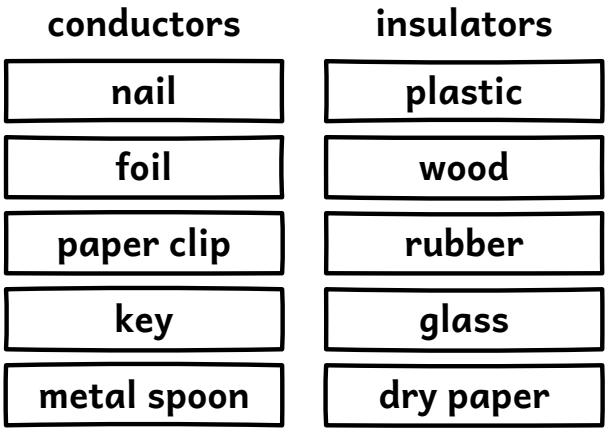
Water with salt or other things mixed in it conducts. Tap water, rain, sea water and sweat all have such things. A wet hand lets electricity pass.

Your torch cell may not light a bulb through water. It pushes too gently. The mains pushes far harder. Through water, it can kill.

Be safe. Never touch a plug, a switch or a wire with wet hands. Keep electrical things away from baths, wet floors and rain. Never test water with the mains.

SEE IT THREE WAYS

As a picture

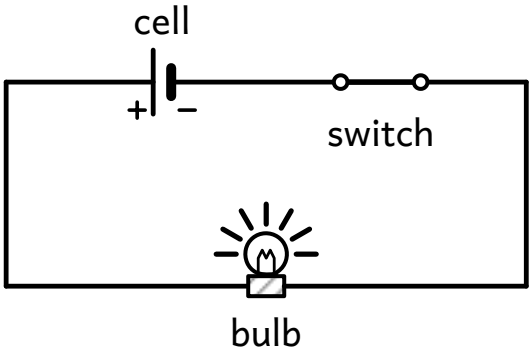


In words

Metals let electricity pass. They are conductors. Plastic, wood, rubber, glass and dry paper do not. They are insulators.

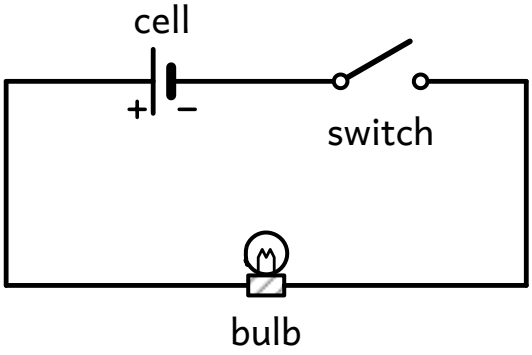
A **switch** opens or closes a gap in the loop. It lets you turn a bulb on and off.

A switch is **closed** when its lever touches both contacts. The loop is complete, and the bulb lights.



The switch is closed. The loop is complete. The bulb lights.

A switch is open when its lever is lifted. There is *a gap*. The bulb is off.



The switch is open. There is *a gap*. The bulb is dark.

The switch on *a* torch slides *a* metal strip. It joins two parts inside, or breaks them *apart*.

TRY IT

Test materials and make a switch

You need: a torch cell marked 1.5 V and a small torch bulb, three strips of kitchen foil, folded long and thin, tape, a nail or a metal spoon, and a metal paper clip, a stick, a piece of plastic, dry paper and a rubber band.

Be safe: Use only a torch cell. Never let strip A touch strip B. That joins the two ends of the cell. The foil gets hot fast.

1. Use three foil strips and tape. Strip A joins the cell knob to the bulb side.
2. Strip B starts at the flat end of the cell.
3. Strip C starts at the bulb tip. Leave a gap between B and C.
4. Press both free ends on a nail. Does the bulb light?
5. Test the other things the same way. Write lit or dark for each.
6. Now lay a paper clip across the gap. A foil strip works too.
7. Lift it off. That is a switch.

What you will see: The bulb lights with the nail, the spoon and the paper clip. These are metals. It stays dark with the stick, the plastic, dry paper and rubber. A paper clip across the gap is a switch. Lay it down to close the loop. Lift it to open the loop. Rub off paint or rust where the foil touches. No cell or bulb? Read the table. Or switch a torch on and off. Do not open it.

If you cannot try it, this is what happens.

thing	bulb
nail	lit
paper clip	lit
foil	lit
stick	dark
plastic	dark
dry paper	dark
rubber band	dark

A WRONG IDEA MANY PEOPLE HAVE

~~Shiny things let electricity pass.~~

Why it feels right: Shiny foil and spoons let electricity pass. So shine seems to be the clue.

The test that breaks it: Use your tester. Touch the free ends to a glass bead or shiny plastic. It is shiny, but the bulb stays dark. Now rub a dull grey nail clean with paper. Touch the ends to it. The bulb lights.

What is true: Shine does not matter. The material does. Metals conduct. Glass and plastic do not.

KEY WORDS

conductor
a material that lets electricity pass. Metals are conductors.

insulator
a material that does not let electricity pass.

switch
a part that opens or closes a gap in the loop.

closed
a closed switch has no gap. The loop is complete.

BACK TO YOUR GUESS

The answer is C: Metals do. Plastic and wood do not.

Metals let electricity pass. Plastic, wood, rubber, glass and dry paper do not. Shine does not matter.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Which of these is a conductor?

   A A wooden spoon

   B A steel nail

   C A rubber band

   Answer at the back of the book.

2. Why do wires have a plastic coat?

   A Plastic is an insulator. It keeps electricity in the wire.

   B Plastic carries the electricity.

   C Plastic makes the wire stronger.

   Answer at the back of the book.

3. Tariq touches the free ends to a shiny glass bead. The bulb stays dark. Why?

   A The bead is too small.

   B Shiny things never let electricity pass.

   C The bulb is broken.

   D Glass is an insulator.

   Answer at the back of the book.

4. A switch is open. What does the bulb do?

   A It is lit, because open lets electricity in.

   B It is dark, because there is a gap.

   C It is lit, but dim.

   Answer at the back of the book.

5. **From an earlier chapter**

   A loop has a cell and a bulb. One wire has a gap. What happens?

   A The bulb is dim.

   B The bulb lights.

   C The bulb stays dark.

   Answer at the back of the book.

6. Why must your hands be dry near electricity?

   A Water with salt or dirt in it lets electricity pass.

   B Water is an insulator.

   C Water makes wires cold.

   Answer at the back of the book.

7. Kofi says a switch makes electricity. Is he right?

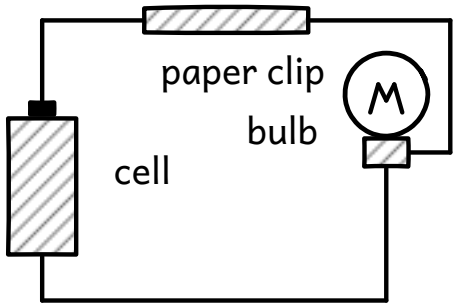
   A Yes. Closing it makes electricity.

   B No. A switch only opens or closes the loop.

   C No. A switch only makes the bulb brighter.

   Answer at the back of the book.

8. Look at the picture. Ana lays a paper clip across the gap. What does the bulb do?



   A It lights. A paper clip is metal.

   B It stays dark. A paper clip is too small.

   C It stays dark. Only wires carry electricity.

   Answer at the back of the book.

9. Which of these is an insulator?

   A A paper clip

   B Shiny kitchen foil

   C A dry wooden stick

   D Salty water

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Metals are conductors. They let electricity pass. Plastic, wood, rubber, glass and dry paper are insulators. Water with salt or dirt in it conducts, so keep hands dry. A switch opens or closes a gap in the loop.

Draw: A loop with a cell, a bulb and a gap. Lay a nail across the gap. Draw lines round the bulb.

S2.8.8 CHAPTER 8

Circuit drawings

How can I draw a circuit so anyone can read it?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Use a short mark for each part.
- ☐ **B** Draw every part exactly as it looks.
- ☐ **C** Use words only, with no drawing.

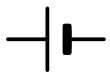
BY THE END YOU CAN

- Draw a circuit using symbols for a cell, bulb, wire and switch
- Predict from a drawing whether a bulb will light

Drawing a real cell and bulb takes time. So people draw circuits with short marks. Each mark is called a **symbol**.

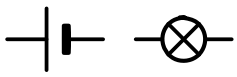
DRAW IT FIRST

Draw the four circuit symbols



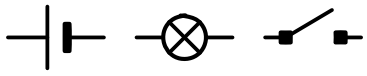
cell

1 Draw a long line and a short thick line. Write cell.



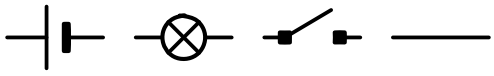
cell bulb

2 Draw a circle with a cross inside. Write bulb.



cell bulb switch

3 Draw two dots with a lifted lever. Write switch.



cell bulb switch wire

4 Draw one straight line. Write wire.

A switch can be open or closed. An open switch has its lever lifted. A closed switch has its lever lying flat.



switch open switch closed

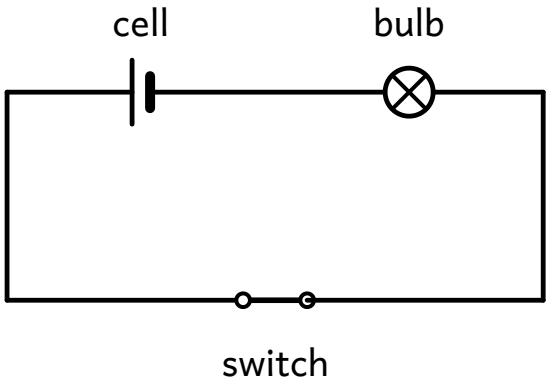
An open switch leaves a gap. A closed switch has no gap.

One cell is one long line and one short line. The long line is the plus end, +. On a real cell, that is the knob end. In drawings we say cell, not battery. Two or more cells joined make a battery.

A drawing of a whole circuit is a **circuit diagram**. Wires are straight lines with square corners.

SEE IT THREE WAYS

As a picture



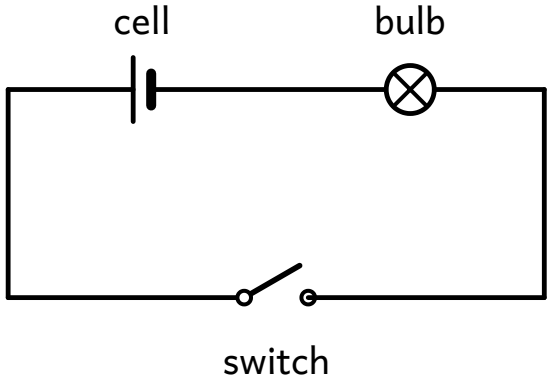
In words

The switch is closed. The wires make a complete loop with a cell in it. The bulb lights.

You can tell if a bulb will light. Trace the loop with your finger. Start at one end of the cell.

Follow the wire round. If you meet an open switch, stop. There is a gap. The bulb stays dark.

If you get back to the start, the loop is complete. Check there is a cell. Then the bulb lights.



The switch is open. There is a gap. The bulb stays dark.

A circuit with no cell stays dark too. Nothing pushes the electricity round.

TRY IT

Draw a circuit and predict

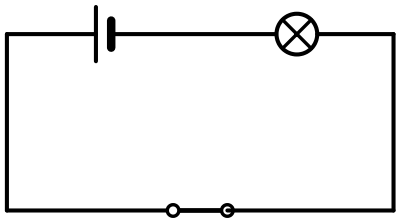
You need: paper and a pencil, a ruler or a straight edge, if you have one, if you can, your cell, bulb, foil and paper clip.

Be safe: Use only a torch cell. Never let the foil from the two cell ends touch. It gets hot fast.

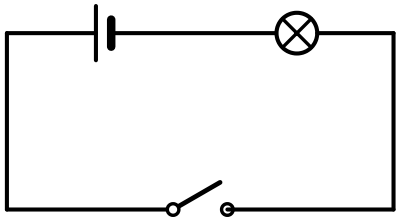
1. Draw a cell, a bulb and a switch in a loop. Use symbols.
2. Draw the switch closed. Trace the loop with your finger.
3. Will the bulb light? Write yes or no.
4. Draw it again with the switch open. Write yes or no.
5. If you can, build both. Use a paper clip as the switch. Check your answers.

What you will see: With the switch closed, the loop is complete. The bulb lights. With the switch open, there is a gap. The bulb stays dark. A drawing can predict what the real circuit does. No parts? The drawings are the whole activity.

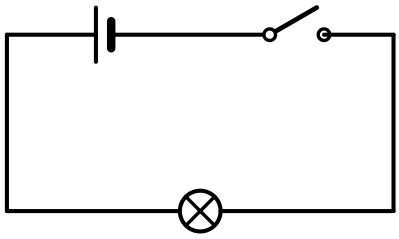
If you cannot try it, this is what happens.



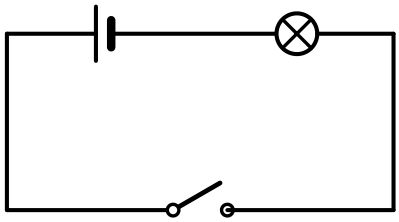
bulb lights



bulb dark



switch before the bulb



switch after the bulb

The switch is open in both. In both, the bulb stays dark.

A WRONG IDEA MANY PEOPLE HAVE

~~A switch only stops the bulb if it comes before the bulb.~~

Why it feels right: Electricity leaves the cell and meets the switch first. It seems to stop only what comes next.

The test that breaks it: Look at the two drawings. Open the switch in each. Trace each loop with your finger. Both have a gap. Or build it. Move the paper clip switch to the other side of the bulb. The bulb is dark both times.

What is true: All the parts are in one loop. A gap anywhere stops the whole loop.

KEY WORDS

symbol
a short mark that stands for a part, such as a cell.

circuit diagram
a drawing of a circuit made with symbols.

BACK TO YOUR GUESS

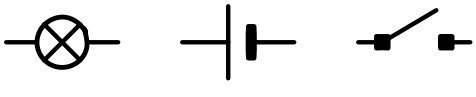
The answer is A: Use a short mark for each part.

People use symbols. These are short marks for each part. Anyone can read them.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Look at the picture. Which one is a cell?



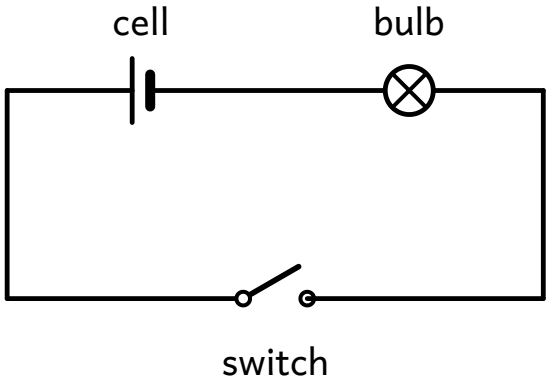
A A

B B

C C

Answer at the back of the book.

2. Look at the drawing. Will the bulb light?



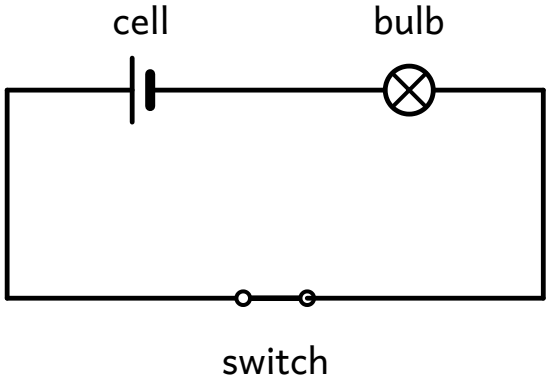
A Yes. There is a cell and a bulb.

B Yes. The wires all join up.

C No. The open switch leaves a gap.

Answer at the back of the book.

3. Look at the drawing. Will the bulb light?



A No. A switch always stops a bulb.

B No. There is no battery.

C No. A bulb needs two cells.

D Yes. The loop is complete.

Answer at the back of the book.

4. A drawing has a bulb and a closed switch, but no cell. Will the bulb light?

A Yes. The switch is closed.

B No. Nothing pushes the electricity round.

C Yes. The wires make a loop.

Answer at the back of the book.

5. Draw a circuit with a cell, a bulb and a closed switch. Will the bulb light?

Answer at the back of the book.

6. **From an earlier chapter**

Which would light the bulb if laid across a tester gap?

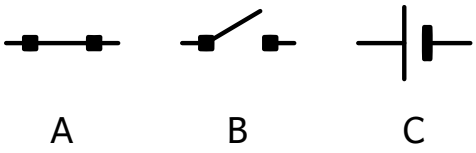
A A wooden stick

B A plastic comb

C A metal paper clip

Answer at the back of the book.

7. Look at the picture. Which one is a closed switch?



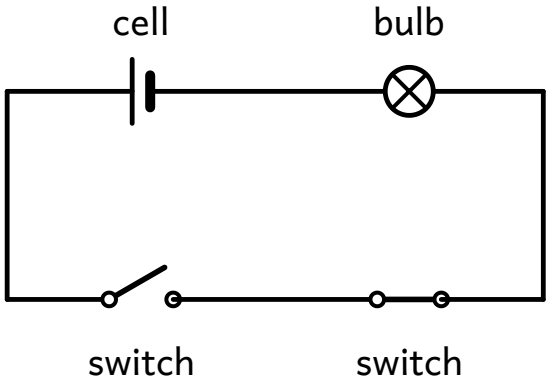
A A

B B

C C

Answer at the back of the book.

8. Look at the drawing. It has two switches. Will the bulb light?



A Yes. One switch is closed.

B No. One open switch leaves a gap.

C Yes. There is a cell.

Answer at the back of the book.

9. Why do people draw circuits with symbols?

A Symbols show exactly how a bulb looks.

B Real parts cannot be drawn.

C Symbols are quick to draw and anyone can read them.

D Symbols are only for people who build circuits for work.

Answer at the back of the book.

10. A circuit has an open switch before the bulb. Ravi moves it to the other side of the bulb. What happens?

    A The bulb lights, because the switch is now after the bulb.

    B The bulb lights, but it is dim.

    C The bulb lights, because moving a switch closes it.

    D The bulb stays dark, wherever the open switch is.

Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

A cell is a long line and a short line. A bulb is a circle with a cross. A switch has a lever. A bulb lights only in a complete loop. A gap or an open switch stops it.

Draw: A loop with a cell, a bulb and a switch, as symbols.

Key words, A to Z

Every key word in this book, what it means, and the chapter that teaches it.

attract
to pull close. S2.8.1, S2.8.2

cell
a small thing that makes electricity from chemicals. Many people say battery. S2.8.5

circuit
a path round from one end of the cell to the other. S2.8.6

circuit diagram
a drawing of a circuit made with symbols. S2.8.8

closed
a closed switch has no gap. The loop is complete. S2.8.7

compass
a tool with a magnet needle that points north and south. S2.8.4

conductor
a material that lets electricity pass. Metals are conductors. S2.8.7

contact point
a place where a wire must touch. A bulb has two. S2.8.6

force
a push or a pull. S2.8.3

gap
a break in the loop. It stops the electricity. S2.8.6

insulator
a material that does not let electricity pass. S2.8.7

magnet
a thing that pulls iron and steel toward it. S2.8.1

magnetic
pulled by a magnet. S2.8.1

magnetic force
the pull of a magnet. It goes through paper, cloth, water and wood. S2.8.3

magnetise

to make a thing into a magnet. S2.8.4

mains
the strong electricity sent to buildings along wires. It can kill. S2.8.5

needle
a thin piece of steel. Floating, it turns to point north and south. S2.8.4

pole
an end of a magnet, where the pull is strongest. N or S. S2.8.2

repel
to push away. Like poles do this. S2.8.2

strength
how hard a magnet pulls. Count clips to compare. S2.8.3

switch
a part that opens or closes a gap in the loop. S2.8.7

symbol
a short mark that stands for a part, such as a cell. S2.8.8

Answers

S2.8.1. What magnets pull

1. **A steel paper clip**

   Steel is magnetic. Wood and copper are not.

   - **If you chose A:** Wood is not magnetic. A magnet pulls only a few kinds of things.
   - **If you chose B:** Copper is a metal, but it is not magnetic. A magnet does not pull every metal.

2. **No. It does not pull copper or aluminium.**

   A magnet pulls iron and steel, nickel and cobalt. Copper and aluminium are metals that it does not pull.

   - **If you chose B:** Foil is aluminium and wire is often copper. A magnet does not pull either.
   - **If you chose C:** A bigger magnet does not change which things are magnetic.

3. **Copper wire and aluminium foil**

   Both are metals, but neither is magnetic.

   - **If you chose A:** Iron and steel are the things a magnet pulls.
   - **If you chose C:** The steel nail is pulled. Only the wood is not.

4. **To pull close**

   A magnet attracts iron and steel. It pulls them close.

   - **If you chose A:** Attract means to pull close. Push away is the opposite.
   - **If you chose B:** Attract has nothing to do with heat. It means to pull close.

5. **Pulled: iron nail, steel clip. Not pulled: wooden stick, plastic comb, aluminium foil.**

   A magnet pulls iron and steel. It does not pull wood, plastic or aluminium.

6. **Foil is aluminium, a metal that is not magnetic.**

   A magnet pulls iron and steel. Aluminium is a metal that it does not pull.

   - **If you chose A:** Foil is a metal. It is aluminium. Not every metal is magnetic.
   - **If you chose B:** Weight does not decide it. A magnet can pull a light steel pin. It does not pull heavy copper.
   - **If you chose C:** A stronger magnet does not change which things are magnetic. Foil is still not pulled.

7. **The thing is magnetic. It may be iron or steel.**

   Only magnetic things jump to a magnet. Iron and steel are magnetic.

   - **If you chose B:** Copper and aluminium are metals. They do not jump to a magnet.
   - **If you chose C:** A magnet pulls iron and steel that are not magnets. The thing may be a magnet, but it need not be.

S2.8.2. North and south poles

1. **They push apart.**

   Like poles repel.

   - **If you chose A:** N and N are like poles. Like poles push apart. Only unlike poles pull together.
   - **If you chose C:** Two magnets always act on each other when they are close.

2. **They will pull together.**

   The facing ends are S and N. Unlike poles pull together.

   - **If you chose B:** The ends that face each other are S and N. Those are unlike poles. They attract.
   - **If you chose C:** Different poles are the ones that pull. Magnets act on each other when they are close.

3. **S**

   It pulls, so the poles are unlike. The other pole is S.

   - **If you chose A:** N and N push apart. A pull means the poles are unlike.
   - **If you chose B:** Only an S pole pulls an N pole. An N pole pushes it away.

4. **A steel nail**

   A magnet pulls iron and steel.

   - **If you chose B:** Wood is not magnetic. Go to S2.8.1.
   - **If you chose C:** Foil is aluminium. A magnet does not pull it. Go to S2.8.1.

5. **Bring the marked N end near each end of the other. The end that is pushed away is N. The end that is pulled is S.**

   Like poles push apart. Unlike poles pull together.

6. **Like poles face each other.**

   Two N poles push apart, and so do two S poles. Like poles repel.

   - **If you chose A:** A pole is not always one thing. N pushes another N, but N pulls an S.
   - **If you chose B:** Size does not decide. Two magnets of one size push apart when like poles meet.
   - **If you chose C:** Unlike poles pull together. It is like poles that push apart.

7. **They push apart.**

   Turning one magnet puts a like pole at the gap. Like poles push apart.

   - **If you chose A:** Turning a magnet round puts its other pole at the gap. The two facing poles are now alike.
   - **If you chose C:** Two magnets close together always act on each other. They pull or they push.

8. **It is pulled toward the S end.**

   Either pole pulls an iron nail that is not a magnet. It is never pushed.

   - **If you chose A:** Only a magnet can push a magnet. A nail that is not a magnet is only pulled.
   - **If you chose B:** Both poles pull a nail. The S pole pulls it too.
   - **If you chose C:** A magnet pulls iron and steel, even when they are not magnets. That is how it lifts a nail.

9. **Bring a marked N end near each end. The end that is pushed away is N.**

   Like poles push apart. The end pushed away from your marked N is also N.

   - **If you chose A:** A nail is pulled by both poles. It cannot show which end is N and which is S.
   - **If you chose B:** Both poles of a magnet pull about as hard. Strength does not tell N from S.

S2.8.3. Magnetic force through things

1. **The clip moves toward the magnet.**

   The pull goes through the cup and the water.

   - **If you chose A:** Magnetic force goes through water. The clip moves.
   - **If you chose B:** A magnet pulls a clip. It does not push it away. Go to S2.8.2.

2. **4 more**

   7 take away 3 is 4. B holds 4 more clips, so B is stronger.

   - **If you chose A:** You added. To find how many more, take 3 away from 7.
   - **If you chose C:** 7 is how many clips B holds. It is not how many more. Take 3 from 7.

3. **B**

   B holds 6 clips. A holds 3. The magnet that holds more clips is stronger.

   - **If you chose A:** A holds fewer clips. The magnet that holds more is stronger.
   - **If you chose C:** They hold different numbers of clips. So one is stronger.

4. **No. The pull works across a gap.**

   Magnetic force acts across a gap. It gets weaker as the gap grows.

   - **If you chose B:** A magnet can pull a clip from a little way off. It can pull through paper.
   - **If you chose C:** Every magnet pulls across a gap. A weak magnet pulls across a small gap.

5. **They push apart.**

   Like poles repel.

   - **If you chose A:** S and S are like poles. Like poles push apart. Go to S2.8.2.
   - **If you chose B:** Two magnets always act on each other when they are close. Go to S2.8.2.

6. **Lay a clip on the cloth. Hold the magnet under the cloth. If the clip moves, the pull goes through.**

   The magnet does not touch the clip. If the clip moves, the force passed through the cloth.

7. **The small one, because it holds more clips.**

   The magnet that holds more clips is stronger. A big magnet is not always strong.

   - **If you chose A:** Size does not decide. The small magnet holds more clips, so it is stronger.
   - **If you chose B:** Magnets differ in strength. Count the clips each one holds.

8. **The gap is wide, so the pull is too weak.**

   The pull gets weaker as the gap grows. A thick pile keeps the clip too far away.

   - **If you chose B:** Cloth lets the pull through. A thin cloth does not stop the clip.
   - **If you chose C:** A magnet pulls across a gap. The gap here is too wide for this magnet.

9. **Dip each magnet into the same pile of the same clips.**

   A fair test changes one thing only. Here only the magnet changes.

   - **If you chose A:** Clips of two sizes make the test unfair. Use the same clips each time.
   - **If you chose B:** Each magnet needs the same try. One dip each, in the same pile.
   - **If you chose C:** Looks are not a test. Count the clips each magnet holds.

10. **Paper, cloth, water and wood.**

    The pull goes through all of them. It gets weaker as the gap grows.

    - **If you chose A:** Paper, cloth and wood are not clear. The pull goes through them too.
    - **If you chose B:** Water and wood let the pull through too. Only a wide gap makes it too weak.
    - **If you chose C:** A magnet pulls across a gap. It pulls through many things.

S2.8.4. Making a compass

1. **Stroke it many times one way with a magnet.**

    Many strokes one way line up the needle. It becomes a magnet.

    - **If you chose A:** Strokes the other way undo the work. Stroke one way only.
    - **If you chose C:** Water does not make a magnet. You need to stroke it with a magnet.

2. **Roughly north and south**

    The Earth acts like a giant magnet. The needle lines up with it.

    - **If you chose B:** A wall does not pull the needle. The Earth acts like a magnet.
    - **If you chose C:** The needle does not follow the Sun. It lines up with the Earth.

3. **N**

    The black half of a compass needle points north. The dial turns, but the needle still points to N.

    - **If you chose A:** The black half points north, to N. Turn the dial, and the needle still points to N.
    - **If you chose B:** S is where the white half points. The black half points north.
    - **If you chose C:** The black half points north, to N.

4. **The Earth acts like a giant magnet.**

    The needle is a magnet. It lines up with the Earth, so one end points north.

    - **If you chose A:** Water does not push it north. The needle is a small magnet that lines up with the Earth.
    - **If you chose B:** The leaf only holds the needle up. It does not turn it.
    - **If you chose C:** Wind would push it any way. In still air the needle turns back to the same way.

5. **A steel needle**

   A magnet pulls iron and steel. A needle is steel.

   - **If you chose A:** Wood is not magnetic. Go to S2.8.1.
   - **If you chose C:** Plastic is not magnetic. Go to S2.8.1.

6. **Stroke a needle many times one way with a magnet. Lay it on a leaf on still water. Wait. The needle turns to point roughly north and south.**

   Stroking makes the needle a magnet. The leaf lets it turn. The Earth lines it up.

7. **The leaf holds it up, so it can turn freely.**

   A steel needle sinks in water. The leaf keeps it afloat, and it can turn.

   - **If you chose B:** A leaf is not magnetic. Stroking with a magnet makes the needle a magnet.
   - **If you chose C:** On the water the leaf lets the needle turn. A needle on a table cannot turn so well.

8. **It turns back and again points roughly north and south.**

   The Earth lines the needle up. The needle points the same way when the bowl turns.

   - **If you chose A:** The needle lines up with the Earth, not with the bowl. It turns back to point the same way.
   - **If you chose B:** The needle only needs still water. Then it lines up again.

9. **It turns toward the magnet.**

   A near magnet pulls harder than the Earth. Keep a compass away from magnets.

   - **If you chose A:** A near magnet pulls the needle much harder than the Earth.
   - **If you chose C:** Take the magnet away and the needle usually turns back to north.

10. **The black half.**

    The black half of the needle points north. The white half points south.

    - **If you chose A:** The white half points south, to S.
    - **If you chose B:** The needle keeps its way. The black half always points north, however you turn the dial.

S2.8.5. Electricity: safe and unsafe

1. **A pocket torch**

   A torch has cells inside it. An electric kettle and iron use the mains.

   - **If you chose A:** An electric kettle plugs into the wall. It uses the mains.
   - **If you chose B:** An electric iron plugs into the wall. It uses the mains.

2. **Mains electricity can kill.**

   The mains pushes very hard. It can stop your heart. Keep away from sockets.

   - **If you chose B:** The danger is to you, not to the socket. Mains can kill.
   - **If you chose C:** A socket has no cell. It is joined to the mains.

3. **Stay far away and tell a grown up at once.**

   The wire may carry mains electricity. Only trained people go near it.

   - **If you chose A:** A damp stick can let electricity pass. Stay far away.
   - **If you chose B:** Dry hands are not safe. The mains can kill.
   - **If you chose C:** The ground near the wire can carry electricity. Stay far away, not close.

4. **A small torch cell marked 1.5 V**

   A small torch cell is gentle. A car battery is not.

   - **If you chose B:** A car battery can burn you and it can explode. Never use one.
   - **If you chose C:** The inside of a cell can burn your skin and eyes. Never cut one open.

5. **An iron nail**

   A magnet pulls iron and steel. It does not pull plastic or wood.

   - **If you chose A:** A magnet does not pull plastic. It pulls iron and steel. Go to S2.8.1.
   - **If you chose B:** A magnet does not pull wood. It pulls iron and steel. Go to S2.8.1.

6. **Cell: torch and toy car. Mains: electric kettle and electric iron.**

   A torch and a toy car carry their own cells. The electric kettle and iron plug into the wall.

7. **No. The mains can kill, even in a moment.**

   The mains pushes at least 60 times harder than a torch cell. Never touch a socket.

   - **If you chose A:** The mains is strong. Even a quick touch can hurt or kill.
   - **If you chose B:** Shoes do not make a socket safe. Never touch it.
   - **If you chose C:** Dry hands are not safe. Never touch a socket, quick or slow.

8. **Keep it away from little children and tell a grown up.**

   A button cell is small enough to swallow. A swallowed one burns inside.

   - **If you chose A:** A swallowed button cell burns inside. Keep it away from little children.
   - **If you chose C:** What is inside a cell can burn your skin and eyes. Never cut one open.

9. **The mains pushes far harder, so it can kill.**

   The mains is 100 V or more. A torch cell is 1.5 V. The mains pushes much harder.

   - **If you chose A:** The numbers are very different. The mains pushes far harder than a cell.
   - **If you chose B:** Size does not matter. 1.5 V is a gentle push.
   - **If you chose D:** Where it comes from does not make it safe. 100 V or more can kill.

S2.8.6. A simple circuit

1. **A second wire, from the flat end to the tip**

   The loop needs a wire from the flat end to the tip.

   - **If you chose A:** A bigger cell cannot help. The loop has a gap, so nothing goes round.
   - **If you chose B:** The length does not matter. The loop is not complete.

2. **One wire from the knob to the side. One from the flat end to the tip.**

   Each end of the cell joins one contact point of the bulb. That makes a full loop.

   - **If you chose B:** Both wires touch the same contact point. The loop skips the bulb. The wires get hot.
   - **If you chose C:** The flat end has no wire. The loop has a gap.

3. **Both bulbs light, but they are dim.**

   The same electricity goes through both bulbs. The cell has to light two, so each is dimmer.

   - **If you chose A:** The first bulb does not use up the electricity. It goes all the way round.
   - **If you chose C:** The loop is complete and has a cell. So both bulbs light.

4. **Electricity cannot go all the way round.**

   A gap breaks the loop. With no way round, nothing goes through the bulb.

   - **If you chose A:** A bulb holds none. The cell pushes electricity round a full loop.
   - **If you chose B:** Thin wires still work. The gap is the problem.
   - **If you chose C:** A weak cell lights a bulb dimly. With a gap, nothing goes round at all.

5. **Mains electricity from a wall socket**

   The mains pushes at least 60 times harder than a torch cell. It can kill.

   - **If you chose A:** A small torch cell is gentle and safe to use. The mains is the danger. Go to S2.8.5.
   - **If you chose B:** A clock cell is small and gentle. The mains is the danger. Go to S2.8.5.

6. **One wire runs from the knob to the side of the bulb. The other runs from the flat end to the tip.**

   Both cell ends and both contact points are in one loop.

7. **The bulb stays dark. The glass is not a contact point.**

   The loop needs wires on the side and on the tip. The glass leaves a gap.

   - **If you chose B:** A bulb has two contact points, the side and the tip. The glass is not one of them.
   - **If you chose C:** It does not light at all. The strip on the glass does not touch a contact point.

8. **A cell, a bulb and two wires in one full loop.**

   A cell pushes electricity round a complete loop. Both contact points of the bulb are in it.

   - **If you chose A:** The tip touches nothing, so the loop has a gap. Both contact points must be in the loop.
   - **If you chose B:** Nothing pushes the electricity round without a cell. The bulb stays dark.
   - **If you chose C:** Both wires touch one contact point. The loop skips the other one, so the bulb stays dark.

9. **4**

   The cell has 2 ends. The bulb has 2 contact points. Together that is 4, and all 4 must be in the loop.

   - **If you chose A:** You missed one. The cell has 2 ends and the bulb has 2 contact points. That is 4.
   - **If you chose B:** That counts only the cell ends, or only the contact points. Count both.

S2.8.7. Conductors, insulators and switches

1. **A steel nail**

   Steel is a metal. Metals let electricity pass.

   - **If you chose A:** Wood is an insulator. Metals are conductors.
   - **If you chose C:** Rubber is an insulator. Metals are conductors.

2. **Plastic is an insulator. It keeps electricity in the wire.**

   The metal inside carries the electricity. The plastic coat stops it reaching you.

   - **If you chose B:** Plastic is an insulator. The metal inside carries the electricity.
   - **If you chose C:** The coat has a different job. It keeps electricity in and keeps you safe.

3. **Glass is an insulator.**

   Glass does not let electricity pass, however shiny it is.

   - **If you chose A:** Size is not the reason. Glass does not let electricity pass.
   - **If you chose B:** Shiny foil does. Shine does not decide. The material does.
   - **If you chose C:** Test the bulb with a nail across the gap. If it lights, the bulb is fine. Glass is the reason.

4. **It is dark, because there is a gap.**

   An open switch leaves a gap in the loop. Nothing goes round, so the bulb is off.

   - **If you chose A:** Open means a gap in the loop. Electricity cannot go round.
   - **If you chose C:** A gap stops all of it. The bulb is fully dark.

5. **The bulb stays dark.**

   A gap breaks the loop. With no way round, nothing goes through the bulb.

   - **If you chose A:** A gap stops the electricity completely. The bulb stays dark. Go to S2.8.6.
   - **If you chose B:** The loop must be complete. A gap stops the bulb. Go to S2.8.6.

6. **Water with salt or dirt in it lets electricity pass.**

   A wet hand is a conductor. It can let mains electricity go through you.

   - **If you chose B:** The water we meet has things mixed in it. It lets electricity pass.
   - **If you chose C:** Cold is not the danger. Wet hands let electricity into your body.

7. **No. A switch only opens or closes the loop.**

   The cell pushes the electricity. The switch opens or closes the gap.

   - **If you chose A:** A switch makes nothing. The cell pushes the electricity round.
   - **If you chose C:** A closed switch does not change the brightness. It joins the loop, and an open one breaks it.

8. **It lights. A paper clip is metal.**

   The clip joins the two ends of the wire. Metals let electricity pass, so the loop is complete.

   - **If you chose B:** Size does not matter. The clip touches both ends, and metal lets electricity pass.
   - **If you chose C:** Any metal can carry electricity, not only wires. A paper clip is a metal.

9. **A dry wooden stick**

   Wood does not let electricity pass when it is dry. It is an insulator.

   - **If you chose A:** A paper clip is a metal. Metals are conductors.
   - **If you chose B:** Foil is a metal. It is a conductor.
   - **If you chose D:** Water with salt in it lets electricity pass. It is a conductor.

S2.8.8. Circuit drawings

1. **B**

   One cell is a long line and a short thick line.

   - **If you chose A:** A circle with a cross is a bulb.
   - **If you chose C:** A lever between two dots is a switch.

2. **No. The open switch leaves a gap.**

   An open switch breaks the loop. Nothing goes round, so the bulb stays dark.

   - **If you chose A:** A cell and a bulb are not enough. The loop must be complete. Go to S2.8.6.
   - **If you chose B:** The open switch is a gap. A gap stops the whole loop. Go to S2.8.6.

3. **Yes. The loop is complete.**

   The switch is closed and there is a cell. So the loop is complete and the bulb lights.

   - **If you chose A:** Only an open switch stops a bulb. A closed switch joins the loop.
   - **If you chose B:** A cell is the part that pushes. This drawing has one.
   - **If you chose C:** One cell can light a bulb. The loop is complete, so it lights.

4. **No. Nothing pushes the electricity round.**

   A cell pushes the electricity round the loop. Without one, the bulb stays dark.

   - **If you chose A:** A closed switch is not enough. A loop needs a cell to push. Go to S2.8.6.
   - **If you chose C:** A loop with no cell has nothing to push. The bulb stays dark. Go to S2.8.6.

5. **A loop. A long and a short line for the cell. A circle with a cross for the bulb. A lever touching both dots. Yes, the bulb lights.**

   The loop is complete and has a cell. So the bulb lights.

6. **A metal paper clip**

   A paper clip is a metal. Metals are conductors, so the loop is complete.

   - **If you chose A:** Wood is an insulator. It leaves the gap. Go to S2.8.7.
   - **If you chose B:** Plastic is an insulator. It leaves the gap. Go to S2.8.7.

7. **A**

   A closed switch has its lever lying flat on both dots. There is no gap.

   - **If you chose B:** In B the lever is lifted. A lifted lever leaves a gap, so B is an open switch.
   - **If you chose C:** C is a cell. Its mark is a long line and a short thick line.

8. **No. One open switch leaves a gap.**

   Every part is in one loop. A gap stops the bulb, even with a closed switch beside it.

   - **If you chose A:** Both switches are in the one loop. The open one is a gap, so the whole loop stops.
   - **If you chose C:** A cell is needed, but it is not enough. The open switch leaves a gap.

9. **Symbols are quick to draw and anyone can read them.**

   A short mark for each part saves time. People who share the same marks can all read the drawing.

   - **If you chose A:** Symbols do not show looks. They show which part it is and how the parts join.
   - **If you chose B:** Real parts can be drawn. A symbol is just faster, and anyone can read it.
   - **If you chose D:** Anyone can learn the symbols. That is why they are used.

10. **The bulb stays dark, wherever the open switch is.**

    The cell, switch and bulb are in one loop. An open switch is a gap, wherever it sits.

    - **If you chose A:** All the parts are in one loop. A gap anywhere stops the whole loop.
    - **If you chose B:** A gap stops the electricity completely. The bulb is fully dark.
    - **If you chose C:** Moving a switch does not close it. It is still open, so the gap stays.

About this book

For learners who can read short sentences. In many schools this fits children of about 8 to 10, and older learners can use it too. Activities use a fridge magnet or any small magnet, a needle, a torch cell and a bulb if you have them, and say what to do if you do not. Never let a learner touch mains electricity or a wall socket. A learner can work alone: every exercise has its answer and the reason for it.

Written and drawn by attnom. Edition 1.0, 2026-11-08.

This book is free. You may read it, print it, copy it and share it with anyone.

The newest copy is at https://attnom.com/academy/magnets-and-simple-circuits.