

Lesson plan on investigative science

Electricity

Electricity

Pupils performed less well in the TIMSS test when assessed on applying their understanding of electricity in practical contexts. Lessons 1 and 2 provide teachers with classroom activities to teach pupils about electricity through hands-on activities including observations, predictions and planning their own experimental test.

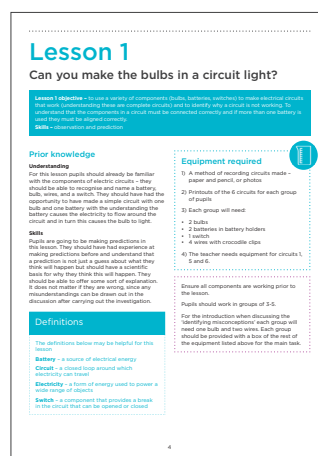
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Lesson plans



Lesson 1

Can you make the bulbs in a circuit light?

Lesson 1 objective - To use a variety of components (bells, buzzers, switches) to make electrical circuits that work (understanding these are complete circuits) and to identify why a circuit does not work. To understand that the components in a circuit must be connected correctly and if more than one battery is used they must be signed correctly.

Skills - observation and prediction.

Prior knowledge

Understanding

For this lesson pupils should already be familiar with the components of electric circuits - they should be able to recognise and name a battery, bulb, wire, and a switch. They should have had the opportunity to have made a simple circuit with one bulb and one battery with the understanding that the battery causes the electricity to flow around the circuit and in turn this causes the bulb to light.

Skills

Pupils are going to be making predictions in this lesson. They should have had experience at making predictions before and understood that a prediction is not just a guess about what they think will happen but should have a rationale, such as 'I think this will happen because...'. They should be able to offer some sort of explanation, it does not matter if they are wrong, but any misunderstandings can be drawn out in the discussion after carrying out the investigation.

Definitions

The definitions below may be helpful for this lesson.

Battery - a source of electrical energy.

Circuit - a closed loop around which electricity can flow.

Electricity - a form of energy used to power a wide range of objects.

Switch - a component that provides a break in the circuit that can be opened or closed.

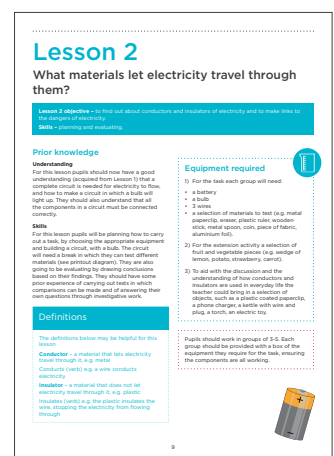
Equipment required

1. A method of recording circuits made - paper and pencil, or photos.
2. Breakdown of kit of circuits for each group of pupils.
3. Each group will need:
 - 2 bulbs.
 - 2 batteries in battery holders.
 - 1 switch.
 - 4 wires (two conductive clips).
4. The teacher needs equipment for circuits 1, 5 and 6.

Ensure all components are working prior to the lesson.

Pupils should work in groups of 5-6.

For the introduction when discussing the identifying misconceptions each group will need one bulb and five wires. Each group should be provided with a box of the rest of the equipment listed above for the main task.



Lesson 2

What materials let electricity travel through them?

Lesson 2 objective - To find out which conductors and insulators of electricity and to make links to the dangers of electricity.

Skills - planning and evaluating.

Prior knowledge

Understanding

For this lesson pupils should have a good understanding provided from Lesson 1 that a complete circuit is needed for electricity to flow, and how to make a circuit in which a bulb will light up. They should also understand that all the components in a circuit must be connected correctly.

Skills

For this lesson pupils will be planning how to carry out a task by choosing the appropriate equipment and building a circuit with a bulb. The circuit will need to be broken in which they can test different materials (see previous diagram). They are also going to be evaluating by choosing materials based on their findings. They should have some prior experience of carrying out tests in which conclusions can be made on the basis of answering their own questions through investigative work.

Definitions

The definitions below may be helpful for this lesson.

Conductor - a material that lets electricity travel through it, e.g. metal.

Conductivity - how well a material conducts electricity.

Insulator - a material that does not let electricity travel through it, e.g. plastic.

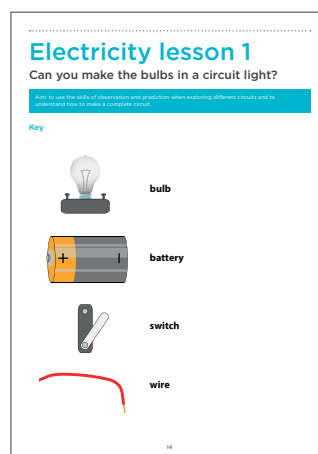
Insulation - e.g. the plastic coating the wire, stopping the electricity from flowing through.

Equipment required

1. For the task each group will need:
 - a battery.
 - 2 wires.
 - a selection of materials to test (e.g. metal objects, wooden pencil case, wooden stick, metal spoon, coin, piece of fabric, aluminium foil).
2. For the extension activity a selection of food and vegetable pieces (e.g. wedge of onion, potato, cucumber, carrot).
3. To set up the discussion and the understanding of how conductors and insulators are used to energise the objects, such as a plastic coated zipper, a phone charger, a kettle with one end plugged a torch, an electric toy.



Lesson printouts







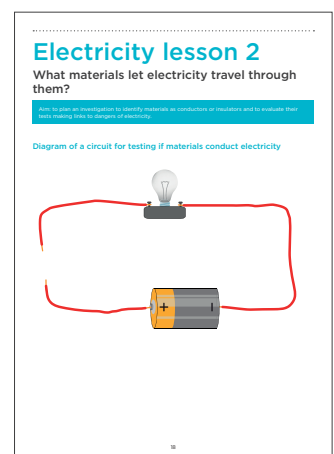
Electricity lesson 1

Can you make the bulbs in a circuit light?

Aim To test the skills of observation and prediction when equipping different circuits and to understand how to make a complete circuit.

Key

-  bulb
-  battery
-  switch
-  wire

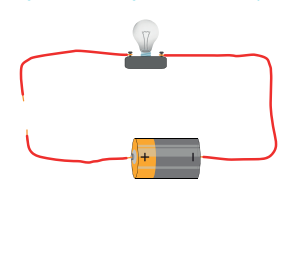


Electricity lesson 2

What materials let electricity travel through them?

Aim To plan an investigation to identify materials as conductors or insulators and to evaluate their tests making links to dangers of electricity.

Diagram of a circuit for testing if materials conduct electricity



Lesson plans



Lesson 1

Can you make the bulbs in a circuit light?

Lesson 1 objective – to use a variety of components (bulbs, batteries, switches) to make electrical circuits that work (understanding these are complete circuits) and to identify why a circuit is not working. To understand that the components in a circuit must be connected correctly and if more than one battery is used they must be aligned correctly.

Skills – observation and prediction

Prior knowledge

Understanding

For this lesson pupils should already be familiar with the components of electric circuits – they should be able to recognise and name a battery, bulb, wires, and a switch. They should have had the opportunity to have made a simple circuit with one bulb and one battery with the understanding the battery causes the electricity to flow around the circuit and in turn this causes the bulb to light.

Skills

Pupils are going to be making predictions in this lesson. They should have had experience at making predictions before and understand that a prediction is not just a guess about what they think will happen but should have a scientific basis for why they think this will happen. They should be able to offer some sort of explanation. It does not matter if they are wrong, since any misunderstandings can be drawn out in the discussion after carrying out the investigation.

Definitions

The definitions below may be helpful for this lesson:

Battery – a source of electrical energy

Circuit – a closed loop around which electricity can travel

Electricity – a form of energy used to power a wide range of objects

Switch – a component that provides a break in the circuit that can be opened or closed

Equipment required

- 1) A method of recording circuits made – paper and pencil, or photos.
- 2) Printouts of the 6 circuits for each group of pupils.
- 3) Each group will need:
 - 2 bulbs
 - 2 batteries in battery holders
 - 1 switch
 - 4 wires with crocodile clips
- 4) The teacher needs equipment for circuits 1, 5 and 6.

Ensure all components are working prior to the lesson.

Pupils should work in groups of 3-5.

For the introduction when discussing the 'Identifying misconceptions' each group will need one bulb and two wires. Each group should be provided with a box of the rest of the equipment listed above for the main task.

Links to everyday life

In this lesson, pupils will be learning about how to make electric circuits with batteries (cells) and bulbs. Circuits are used in many objects which pupils will have used in everyday life. The questions below are designed to be used as a prompt to aid discussion about what we use circuits for in everyday life and to find out what the pupils know about these circuits and how they work.

Questions to prompt pupil discussion (these could be displayed on a whiteboard for pupils to see):

- **What objects do they use every day that need electricity to work?** (e.g. laptop, tablet, phone, television, clock, kettle)
- **Thinking about the objects, what is the electricity used for?** (lighting up a screen, producing sound, heating water, turning a motor)
- **Where does the electricity come from?** (from the mains electricity – which is produced in power stations, or from batteries. They would not be expected to know how electricity is made.)
- **Which types of objects use batteries?** (torches, clocks, mobile phones, some toys, cars)
- **Why do some objects use mains electricity whereas others use batteries?** (e.g. some need more power)
- **Why is it useful for some objects to use batteries?** (e.g. portable)
- **What are disadvantages of batteries?** (run out, not as powerful as mains electricity)
- **What else is needed in an object with batteries for it to work?** (wires, a switch)

Pupils can come up with more questions. Round up any group discussions with a class discussion to identify the key points – that we use many objects every day which need electricity to work – to produce light, sound, heat, movement; that electricity may come from the mains, or from batteries; that batteries can run out and are less powerful than mains electricity; that electricity flows through wires and switches are used to break the circuit, i.e. turn something off and on.

Identifying misconceptions

Pupils may have misconceptions about how circuits work, and therefore it is helpful to identify these at the start of the lesson. Pupils' understanding can then be built on during the lesson as they explore circuits for themselves.

The TIMSS item is assessing pupils' understanding that a complete circuit is needed to work and for a circuit to be complete all the components must be connected correctly; in this case, with more than one battery, the item is also assessing pupils' understanding that the batteries must be aligned correctly – both in the same direction. Pupils should understand electricity flows round a circuit through each component in a continuous loop. If there is any break in this loop the electricity will stop flowing.

Provide each group of pupils with the equipment needed to make a simple circuit (two wires, a bulb and battery). Give them time to see if they can make a circuit so the bulb lights.

Then show them Figure 1.

Figure 1: Electricity example



.....

Ask the pupils the following questions:

- **What is the battery for?**
(The battery provides the energy for the electricity to flow.)
- **Will this bulb light up, and why?**
(No, because it is not a complete circuit – there is not a continuous loop for the electricity to flow.)
- **What would you have to do to make this bulb light?**
(Attach another wire from the bulb to the battery. The wire must go from the left-hand screw of the bulb holder to the negative terminal of the battery. If the picture is displayed on a whiteboard, a pupil could be asked to draw on the second wire.)

Make sure the pupils have been able to make their own simple electric circuit with their components. If needed to reinforce the understanding of how a simple circuit works, the following YouTube clip could be shown: www.youtube.com/watch?v=9yLPMhHE1hQ

Introduction for the task

The aim of this lesson is for pupils to make a series of different circuits, understanding a complete circuit is needed for a bulb or bulbs to light. Before introducing the task, work through the 'Identifying misconceptions' on page 5 with the pupils, making sure pupils can identify that a continuous loop is needed for electricity to flow.

Tell the pupils they are now going to explore how to make a number of electric circuits using the components given to them in their group.

The pupils are then going to be shown some circuits on some printouts and asked to make a prediction about whether the bulb or bulbs in each circuit will light. After they have made their prediction, they will need to make each circuit to test if their prediction is correct. They should be able to give an explanation of why their prediction was correct or incorrect (showing an understanding of what makes a complete (unbroken circuit)).

Task

Give each group of pupils a box containing the selection of electrical components listed in the equipment section on page 4. Suggest someone in the group should sketch each circuit they make and identify if the bulbs light up or not. Alternative means of recording the finished circuits could be used, such as taking a digital photograph and labelling using apps such as skitch or pic collage, or recording as a video with a voice-over to give an explanation of how the circuit was made and why it lights up.

After they have completed the exploratory activity tell pupils they need to make each circuit 1-6 on the printouts - or alternatively display on a whiteboard.

For each circuit they should first make a prediction on whether they think the bulb will light. Can they give an explanation for their prediction?

Then make the circuit. Check they have closed any switch. Observe the light bulb. Was their prediction correct? They can discuss this in their groups. Ask the pupils to note down which of the circuits that worked had the brightest bulb(s), and which had the least bright.

Discussion

Which three circuits were complete? (1, 5, 6)

Why? How do they know they are complete? Why was the bulb or bulbs able to light up in these circuits?

What was wrong with circuits 2, 3 and 4 (circuit 2 the batteries are in opposite directions, circuit 3 has no battery, circuit 4 the battery is not connected correctly).

What happened if they opened the switch in circuit 6? Why is this?

Extension

Ask pupils to look back at their notes for the three circuits that worked – circuits 1, 5 and 6.

Ask them to identify which circuit has the brightest bulb(s), and which has the least bright bulb(s).

See if they can explain why the brightness of the bulbs differs in these circuits (because of the ratio of bulbs to batteries).

Ask pupils to then make circuit 2 again but correct so the bulbs light. Then ask which circuit the bulbs in circuit 2 have similar brightness to – should be circuit 6. See if pupils can explain why (for both circuits there is one battery for one bulb).

See if pupils can predict what will happen if they make a circuit with more bulbs, more batteries, or both. If time allows, give pupils the opportunity to make their circuit and check whether their prediction is correct. Alternatively, if current topic work provides a relevant context, ask pupils to design a circuit with a bright light for a purpose, e.g. a torch for walking through a rainforest at night.

Plenary

Ensure pupils have all understood a complete circuit with a battery and no breaks is needed for electricity to flow. Recap the importance of connecting all the components correctly and check that pupils have understood if there is more than one battery, they must both be orientated in the same direction. Check pupils understand that a switch is used to turn a circuit on or off, and that the switch must be closed to turn it on for a bulb to light as this completes a circuit.

Recap that the brightness of bulbs in the circuit will depend on the number of batteries in the circuit – more batteries per bulb means a brighter bulb. (Note: this is the extension activity and it may be expected that not all pupils will fully understand this concept. It is something that could be explored again in another lesson to reinforce understanding.)

Resources

Ideally this lesson allows pupils to explore making circuits using real equipment, however, if this is not available in your classroom the link below provides an alternative in which pupils can build circuits online. (It should be noted that this resource is designed for KS3, however, if just using the wires and bulbs, it could be used at this level if needed.)

<https://bit.ly/IITCfID>



The aim of this lesson is for pupils to make a series of different circuits to discover what is needed for a bulb to light



Lesson 2

What materials let electricity travel through them?

Lesson 2 objective – to find out about conductors and insulators of electricity and to make links to the dangers of electricity.

Skills – planning and evaluating

Prior knowledge

Understanding

For this lesson pupils should now have a good understanding (acquired from Lesson 1) that a complete circuit is needed for electricity to flow, and how to make a circuit in which a bulb will light up. They should also understand that all the components in a circuit must be connected correctly.

Skills

For this lesson pupils will be planning how to carry out a task, by choosing the appropriate equipment and building a circuit, with a bulb. The circuit will need a break in which they can test different materials (see printout diagram). They are also going to be evaluating by drawing conclusions based on their findings. They should have some prior experience of carrying out tests in which comparisons can be made and of answering their own questions through investigative work.

Definitions

The definitions below may be helpful for this lesson:

Conductor – a material that lets electricity travel through it, e.g. metal

Conducts (verb) e.g. a wire conducts electricity

Insulator – a material that does not let electricity travel through it, e.g. plastic

Insulates (verb) e.g. the plastic insulates the wire, stopping the electricity from flowing through

Equipment required

1) For the task each group will need:

- a battery
- a bulb
- 3 wires
- a selection of materials to test (e.g. metal paperclip, eraser, plastic ruler, wooden stick, metal spoon, coin, piece of fabric, aluminium foil).

2) For the extension activity a selection of fruit and vegetable pieces (e.g. wedge of lemon, potato, strawberry, carrot).

3) To aid with the discussion and the understanding of how conductors and insulators are used in everyday life the teacher could bring in a selection of objects, such as a plastic coated paperclip, a phone charger, a kettle with wire and plug, a torch, an electric toy.

Pupils should work in groups of 3-5. Each group should be provided with a box of the equipment they require for the task, ensuring the components are all working.



Links to everyday life

Before introducing the task below tell pupils that today they are going to be learning about materials that let electricity flow through them (conductors), and materials that do not (insulators). We come across many of these materials in everyday life for all the objects we use that need electricity to work. The following questions could be put up on a whiteboard to prompt some discussions in groups that can then be brought together as a class discussion to find out what pupils already know.

Questions to prompt pupil discussion:

What are wires made of? Why?

(metal, usually copper – because this is a good conductor / lets electricity travel through)

What are wires to electric objects coated with?
(plastic)

Why is this? What is the plastic doing?
(insulating the wire)

What examples can they think of for using materials that don't let electricity through?
(plugs, switches, casing for circuits)

Do they know the name for materials that let electricity through, and materials that do not let electricity through?
(conductors let electricity through and insulators do not let electricity through)

How can electricity be dangerous? How do materials that do not let electricity through help protect us?
(electricity can give us an electric shock as electricity can pass through us. Materials that are insulators stop the electricity from getting to us.)

Note for Teacher

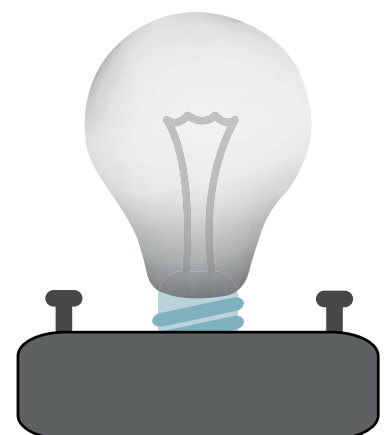
Teacher to bring in variety of objects to provide examples for the discussion – see equipment list.



Identifying misconceptions

The TIMSS item is assessing the pupils' understanding of which materials conduct electricity – the results from TIMSS 2015 suggest that pupils in Northern Ireland are less secure in their understanding of conductors. The prompt questions above will help you explore what your pupils already know. Do they have an idea about the types of materials that let electricity through?

If they are unsure of the correct terms, introduce the words conductor and insulator to describe the property of the materials. Also introduce the use of the words as verbs – conducts and insulates. Depending on the level of understanding of your pupils you could see if they can think of other instances in science when these words are used, e.g. thermal conductors and insulators, sound conductors and insulators.



Introduction for the task

Tell the pupils that they are going to be finding out what types of materials let electricity flow through. Reinforce the terms conductors and insulators by displaying on the whiteboard, for example, as a reminder throughout the lesson.

Discuss with pupils how they might test if materials are conductors or insulators. What could they use to test this?

Task

Ask pupils in groups to sketch a possible testing circuit. Give them a couple of minutes and then discuss their ideas and make sure each group has identified a suitable circuit. (The circuit should have a battery, bulb and three wires to allow a gap between which the materials can be tested.)

Give each group a box with the components as listed in the equipment. Each group can then make their circuit and test the materials provided. The groups should record if each material is a conductor or insulator.

Discussion

Which materials let electricity flow through?

Which did not? How did they know?

Reinforce the terms **conductor** and **insulator**.

Is there anything similar about the materials that are conductors? See if the groups have recognised that all the conductors are metals.

Could they improve their experiment?

What other questions could be asked? e.g.

- Are all metals conductors?
- If metals are covered by an insulator, will the electricity be able to get through? (e.g. plastic coated paperclip)

Extension

Use if there is enough time and you feel the pupils are secure in their understanding of conductors and insulators. Explain that they are now going to test their circuits with some pieces of fruit and vegetables.

Allow 5 minutes for them to carry out some more tests.

What did they find out? (the light bulb did light)

Did some of the fruit and vegetables conduct electricity? (they should have found the light bulb did light for some of the fruit and vegetables and therefore these ones must have conducted electricity)

Why does this show how it can be especially dangerous to plug in electrical appliances with wet hands? (because the electricity can more easily travel through the water into our bodies if we accidentally touch the prongs of the plug or plug socket as we are plugging it in)

What do they think is conducting the electricity? Discuss how water can conduct electricity if it contains dissolved salts or acids. (If water is completely pure it cannot conduct electricity, however tap water will have some impurities which means it can conduct. Fruit and vegetables contain lots of water and also acids and therefore are good conductors.)

Some fruits and vegetables can even act instead of a battery. If time, ask pupils to test out the fruit or vegetables in a circuit with a bulb and no battery. Are any of the fruits or vegetables able to make the bulb light in a circuit with no battery?



Discuss with the pupils how they might test if materials are conductors or insulators

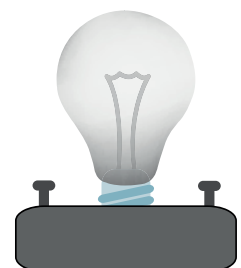
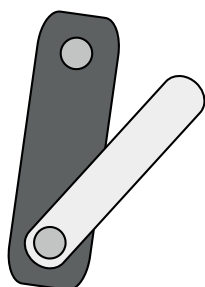
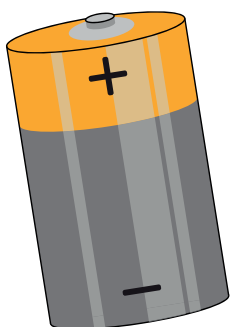
Plenary

Ensure pupils are confident with using the terms conductor or insulator. Recap on how conductors are usually metals, but water can sometimes conduct electricity (if it is not pure) and this can make electricity particularly dangerous to us (as our bodies are made up of a lot of water).

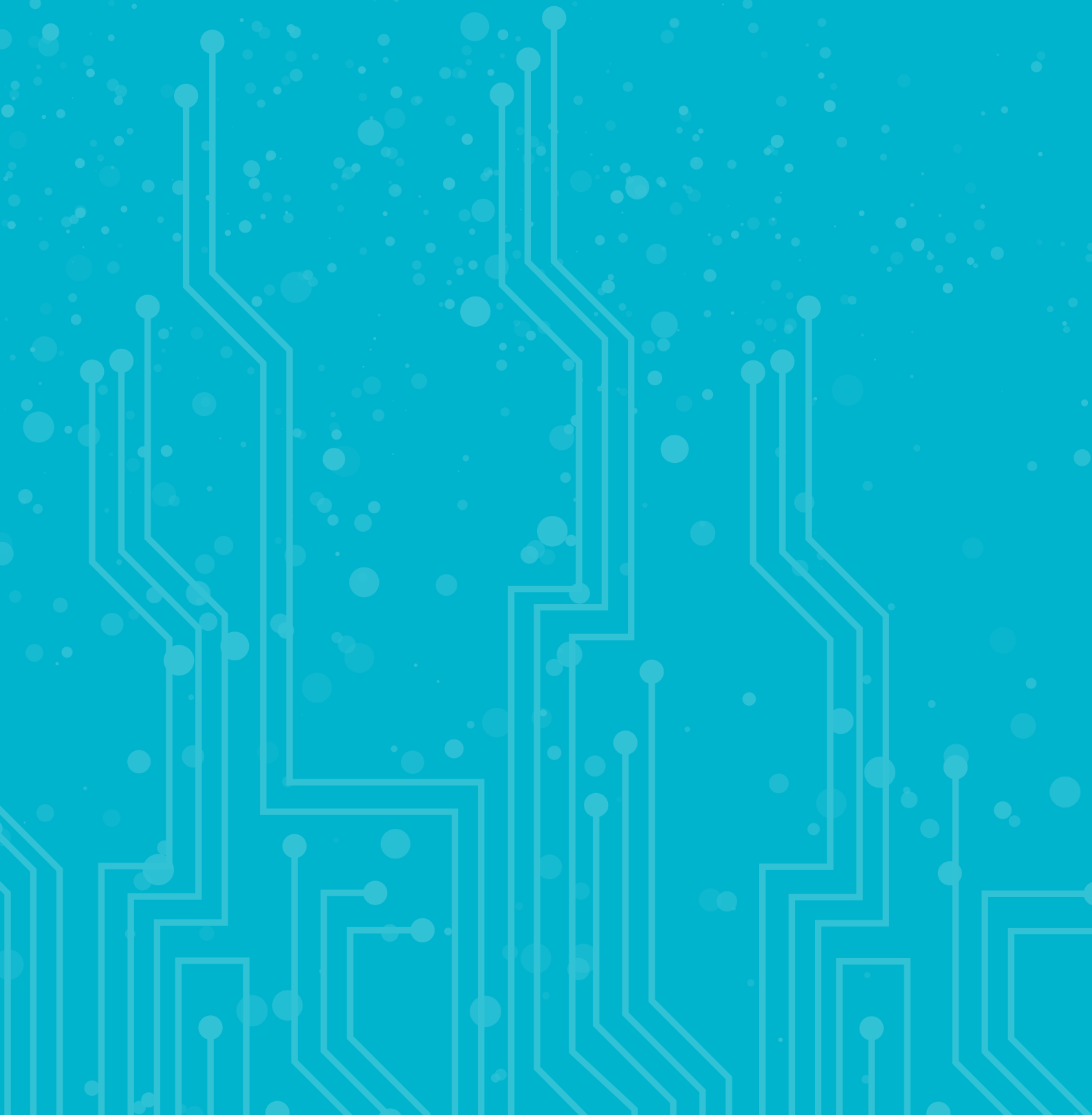
Resources

The KS2 science Bitesize website has a good range of information about circuits, conductors and insulators.

www.bbc.co.uk/education/topics/zj44jxs



Lesson printouts

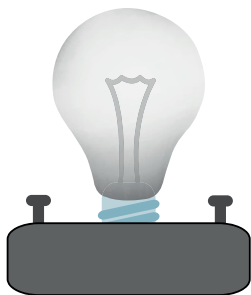


Electricity lesson 1

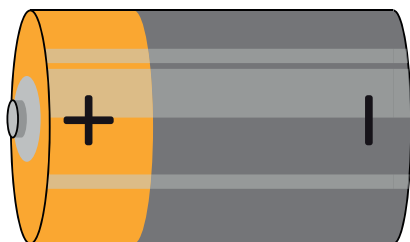
Can you make the bulbs in a circuit light?

Aim: to use the skills of observation and prediction when exploring different circuits and to understand how to make a complete circuit.

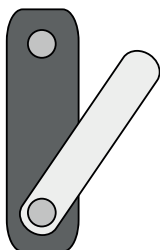
Key



bulb



battery

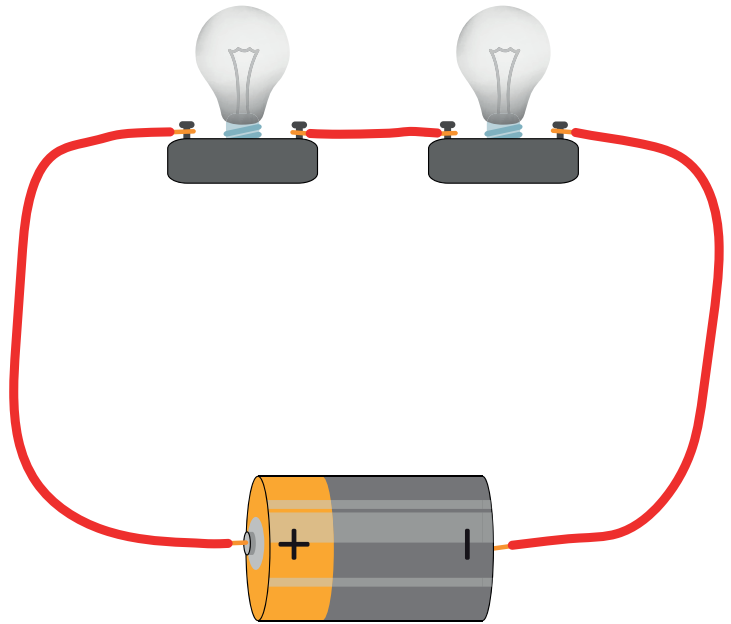


switch



wire

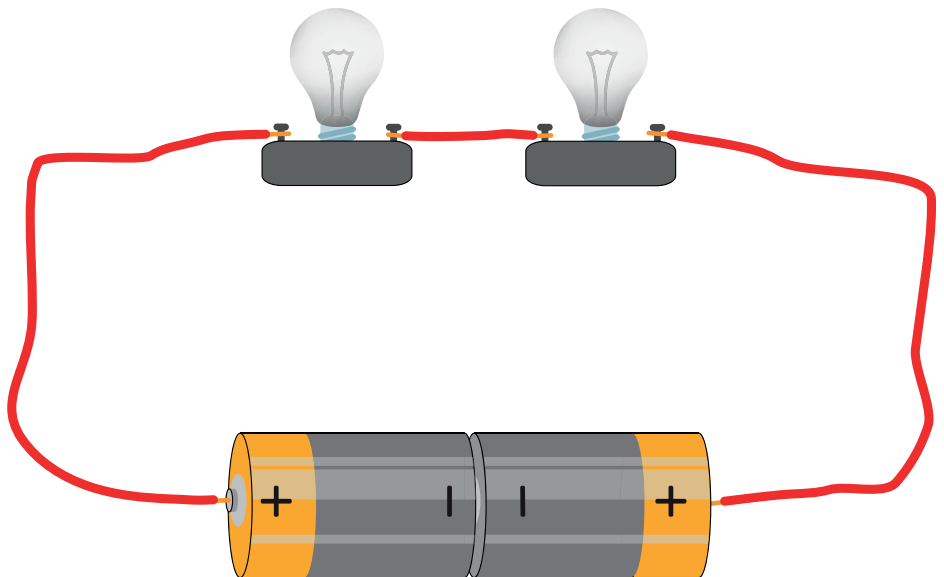
Circuit 1



Tick (✓) if the bulbs light up

Explanation

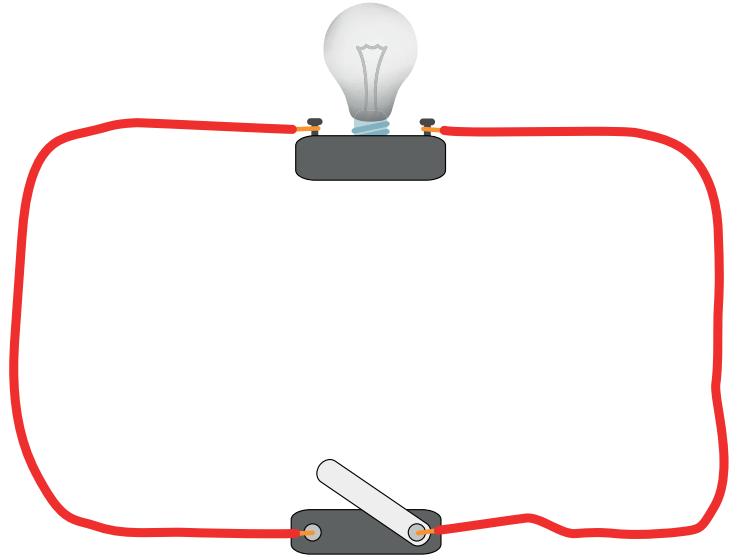
Circuit 2



Tick (✓) if the bulbs light up

Explanation

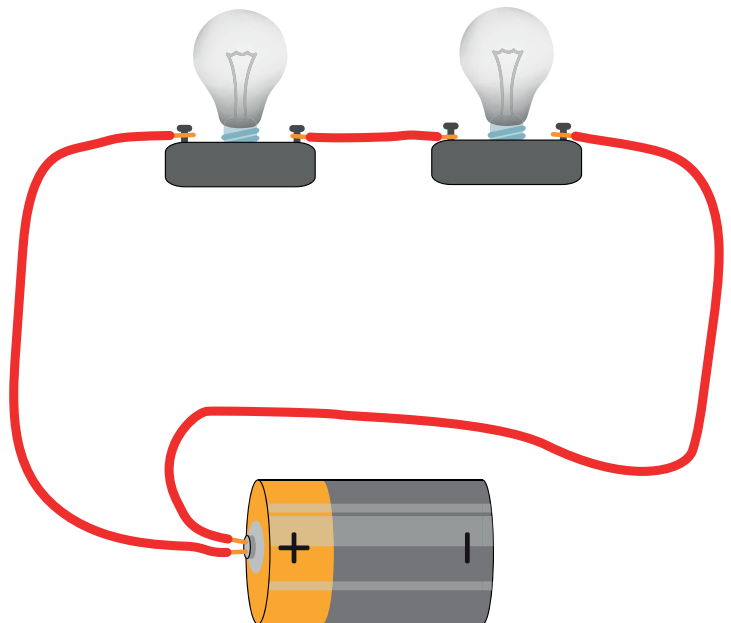
Circuit 3



Close the switch on your circuit. Tick (✓) if the bulb lights up

Explanation

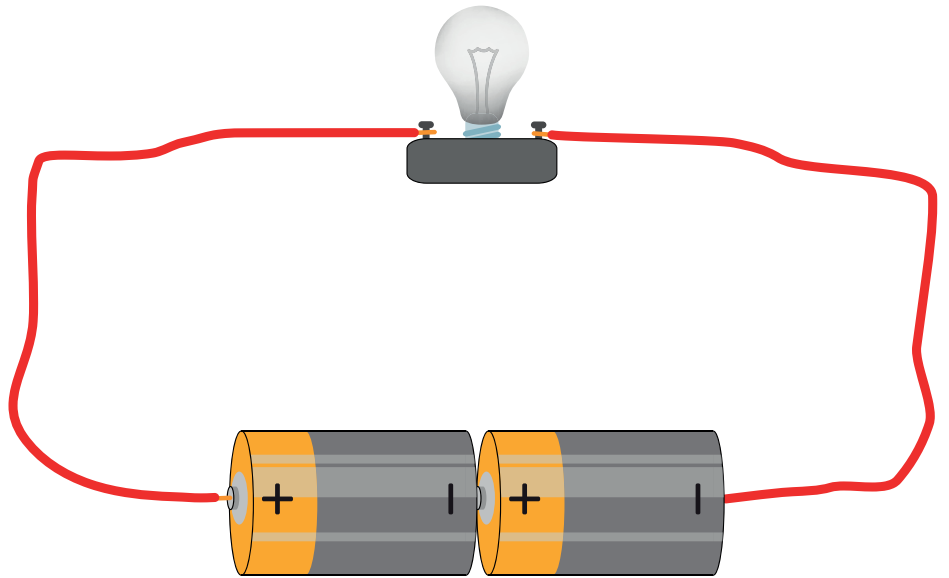
Circuit 4



Tick (✓) if the bulbs light up

Explanation

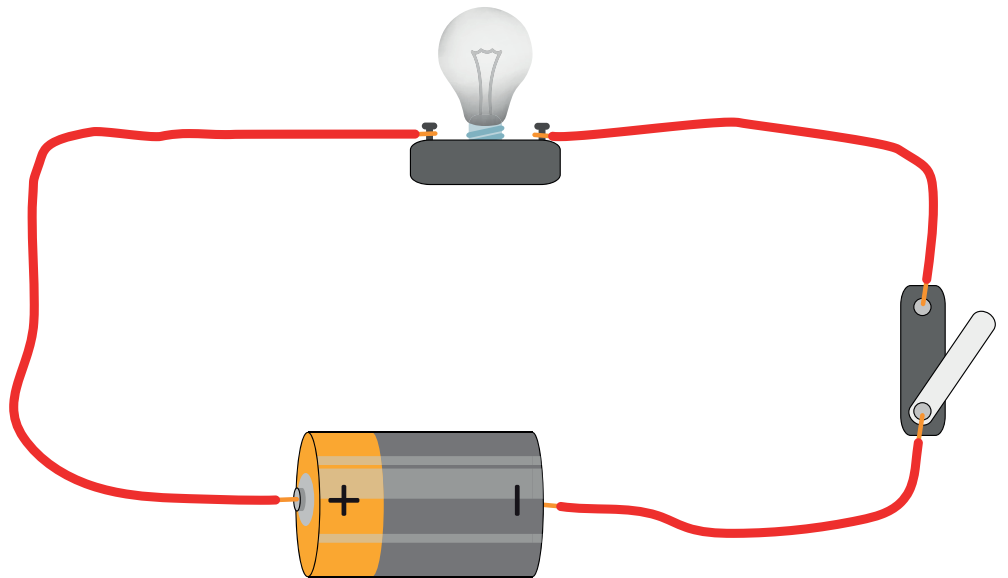
Circuit 5



Tick (✓) if the bulb lights up

Explanation

Circuit 6



Close the switch on your circuit. Tick (✓) if the bulb lights up

Explanation



Electricity lesson 2

What materials let electricity travel through them?

Aim: to plan an investigation to identify materials as conductors or insulators and to evaluate their tests making links to dangers of electricity.

Diagram of a circuit for testing if materials conduct electricity

