Schools Roadshow 2024

ELECTRICITY

Aligned to the National Curriculum, The Curriculum for Excellence & The Curriculum for Wales

5 Electrifying Activities Inside

Suitable for those who attended the BAE Systems Schools Roadshow, and those who didn't.

- **Conductor Detector**
- **Steady Hand Game**
- **Sensational Sensor**
- **Make Your Own Electroscope**
- **DIY Battery**

AGES 8-14

BAE SYSTEMS

ROYAL AIR FORCE

ROYAL NAVY

Developed in partnership with

smallpeice

Dare to imagine

Introduction

We have an exciting collection of electricity activities for teachers to read, plan, and deliver to students.

These activities support the curriculum for students aged **8-14**

If you're a teacher, please read through the activities carefully – they're designed so that you can use the common materials around you, but it's best to make sure you have them all before you start! There is also plenty of careers information at the back. Please complete risk assessments as required by your school.

If you're a student, please be careful and sensible – we want you to have fun, learn about electricity, and take good care of yourselves.

The activities get more difficult as you progress:
You may want to skip to a later activity or stick with the first few – it's entirely up to you.

We're a BUZZ with excitement about these electrifying activities!

For England
Key Stage 2 Science and Key Stage 3 Physics.

For Scotland
The relevant sections for Science and Physics in the Curriculum for Excellence.

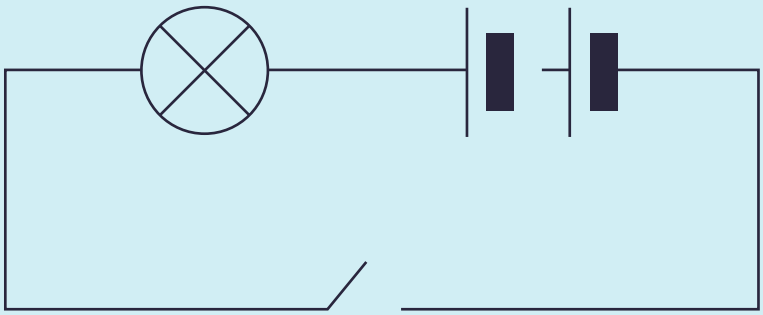
For Wales
The relevant sections for Science and Technology in the Curriculum for Wales.

RECAP OF THE FUNDAMENTALS

Electricity is the presence or flow of charged particles.

Everything is made up of tiny particles, which may have either positive or negative charges. All materials contain negatively-charged particles, called electrons. In some materials, like metals, the electrons are free to move, which means they are good conductors of electricity. An electric current is when electrons flow around a circuit.

Batteries store potential electrical energy. In a complete circuit, a battery can push electrons around the circuit to create an electric current, which we use to operate electronic devices.

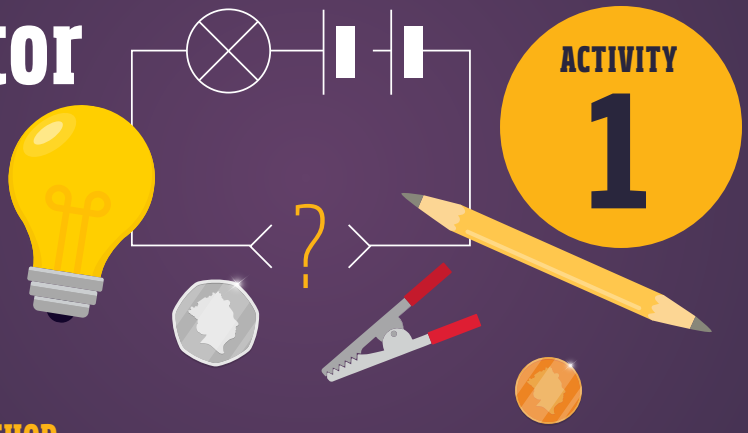


Some materials don't conduct electricity – they are called insulators. Most non-metal materials like wood, plastic and rubber are insulators. We use rubber as an insulator on the outside of wires in circuits so that we don't electrocute ourselves.

Static electricity is the result of an imbalance between negative and positive charges in an object, due to a build-up or deficiency of electrons. Static electricity can be generated by rubbing two different insulating materials together, like a balloon and a jumper. As you rub, negatively-charged electrons move from the jumper to the balloon. Negative charge builds up on the balloon causing static electricity.

Conductor Detector

ACTIVITY 1



Students will learn about conductors and insulators and how they work.

They will build a circuit and use it to test whether different objects are conductors or insulators.

EQUIPMENT

Wires with crocodile clips x 3

Battery holder and cells

Bulb with bulb holder or buzzer
(voltage should match battery)

Objects for students to test
e.g. foil, rubber, pencil, pencil with both ends sharpened, plastic ruler, metal ruler, coins, paper, paper clips

OPTIONAL EXTENSION:

Pieces of card approx. 6 x 10cm

Foil

QUESTIONS FOR STUDENTS

What kinds of materials conduct electricity?

What do we use insulators for?

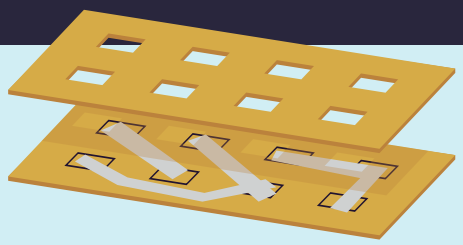
How do insulators keep us safe when using electricity?

METHOD

- Ask students to explain conductors and insulators with examples.
- Challenge students to predict which objects will and won't conduct electricity and explain why.
- Working in pairs, students create a circuit using 2 wires, a battery and a bulb/buzzer, test the components and draw a circuit diagram using correct electrical symbols.
- Disconnect a wire from the battery and connect the third wire in its place, leaving a gap in the circuit. Then draw a new circuit diagram.
- Test whether different objects are conductors or insulators by adding them into the gap in the circuit. If the bulb/buzzer activates then the material is a conductor. If it does not, then it is an insulator.
- Record their results in a table and compare their results to their predictions.
- Ask students to draw conclusions about what type of materials are conductors and insulators. Discuss electrical safety and why insulators are important for electronic equipment.

KEY SKILLS

TEAMWORK · AIMING HIGH · SPEAKING



EXTENSIONS

- Create some connectivity puzzle cards for students to test.
- Cut 8 holes in a piece of card, place it on a piece of card the same size and mark the holes. On the bottom piece connect some of the holes together with foil (as shown). Use masking tape to help insulate overlaps where needed. Stick the pieces together.
- Ask students to test the puzzle cards to see which holes are connected and guess the foil pattern.
- Challenge students to make their own versions for a partner to solve. You may want to pre-cut the holes.

ENRICHMENT

CHECK OUT - **www.bit.ly/spt-dimmer-switch**
Make a dimmer switch with a graphite pencil

RELATED CAREERS

Electrician:

Installs, maintains and repairs electrical power systems. They need a good understanding of conductors and insulators.

Computer Hardware Engineer:

Designs and assembles the essential parts of a computer.

DIFFICULTY RATING = ⚡⚡

TIME FRAME = 30 MINS

Steady Hand Game

ACTIVITY 2

Students will develop their understanding of conductors, insulators and circuits.

They will make their own mini 'steady hand' game.

EQUIPMENT

Pre-stripped wire that is easily bent by hand: one 30cm piece, one 15 cm piece

Wires with crocodile clips x 3

Battery holder and cells

Bulb with bulb holder or buzzer
(voltage should match battery)

Switch (optional)

Piece of corrugated cardboard approx. 5 x 10 cm

Pencil

Masking tape

Wooden spills (optional)

METHOD

- First make the base by making 2 holes in the carboard with a pencil, about 1 cm apart as shown in image 1.
- Thread 2-3cm of the longer piece of wire through the holes and secure by wrapping over the edge of the cardboard and sticking with masking tape (image 2).
- Repeat with the other end of the wire (image 3), however leave the end sticking out as a connection wire for a crocodile clip later.
- Use masking tape to insulate the bottom cm of the wire shape where it meets the card each side, leaving the connection wire clear.
- Now bend the wire into an interesting shape.
- Next make the loop and handle out of the shorter piece of wire, by looping it around the wire shape, twisting the ends together, connecting a crocodile clip to the handle and then insulating with masking tape. You may wish to use wooden spills to sandwich the wire handle.
- Students create a circuit to test their components, then connect into the game: the crocodile clip from the handle connects into the circuit and another clips to the connection wire at the base of the game.
- Students can add an on/off switch to their circuit if they wish.
- When the loop touches the wire, the bulb/buzzer should activate. The challenge is to move it around the whole shape without touching it.
- Ask students to explain how the game works and explain how this functions like a switch. Compare it to similar games like operation.
- Ask students to draw a circuit diagram using the correct symbols, representing the game as a switch.

QUESTIONS FOR STUDENTS

Why does the light/buzzer activate when the loop touches the wire?

Why do we cover the handle with masking tape?

How is this like a switch?

KEY SKILLS

EXTENSIONS

- Challenge students to create a name and logo for their game or even to design some packaging.
- Make this activity into a D.T. project by evaluating existing products, designing before building and evaluating at the end. Use wood rather than cardboard to make this more hardwearing.

ENRICHMENT

CHECK OUT - **www.bit.ly/more-diy-games**

BBC Two - Science Clips, Circuits and Conductors, Using circuits to make games and activities

RELATED CAREERS

Manufacturing Engineer:

Supervises and improves production of products. They are like a master planner, working out the best way to build things by designing the step-by-step process.

Game Designer:

Brings new types of games to life. They create and test prototypes to make sure games work properly.

DIFFICULTY RATING = ⚡⚡⚡

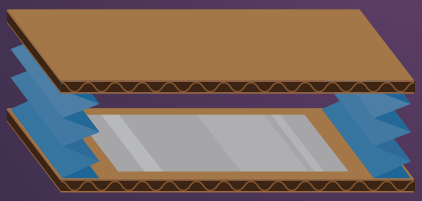
TIME FRAME = 30 MINS

Sensational Sensor

ACTIVITY 3

Students will learn about how conductors are used in a circuit.

They will make their own circuits using a pressure sensor to activate them.



EQUIPMENT

Battery holder and cells

Wires with crocodile clips x 3

Bulb with bulb holder or buzzer (voltage should match battery)

Corrugated cardboard: two rectangles approx. 3 x 8 cm

Card: two rectangles approx. 3 x 8 cm

Foil

Glue

METHOD

- Students follow the instructions to create a pressure sensor.
- Cover one side of each of their pieces of cardboard with foil.
- Make two small springs using their card rectangles by folding them back and forth at least 6 times. The springs should be the same width as the foil-covered pieces.
- Stick the sensor together, with the foil facing inwards and the springs at either end. It is important that the foil pieces are not touching and that there is at least a 2cm gap between the top and bottom.
- Create a circuit using a battery, three wires and either a bulb or a buzzer, leaving a gap in the circuit to add the pressure sensor.
- Connect one crocodile clip to the bottom part of the sensor, making sure it touches the foil at the bottom but not the top. Then attach the second crocodile to the top of the sensor, making sure it only touches the foil on the top, not the bottom.
- When the pressure sensor is pressed, the light/buzzer should turn on.
- Ask students to explain to their partner why the sensor works, using the key words: **Electricity, Conductor, Circuit**.
- Ask students to draw a circuit diagram using correct symbols and representing the sensor as a switch.

QUESTIONS FOR STUDENTS

What might a pressure sensor be used for in real life?

What other types of sensors exist?

Can a sensor be a type of switch?

KEY SKILLS

EXTENSIONS

- Challenge students to design their own sensors:
- How could you make a water sensor?
- What about a sensor which triggers when a drawer is opened?
- How about a motion or vibration sensor?

ENRICHMENT

CHECK OUT - **www.bit.ly/spt-sensor-challenge**

Engineering@Home (Part 2):
No. 2 The Sensor Challenge - YouTube

RELATED CAREERS

Robotics Engineer

Designs, develops and produces robots and automated systems. Sensors are essential to robotics as they allow automated machines to perceive the world.

Engineering Technician

Helps build and test things, like machines or electronic devices, following the plans created by engineers. They play a crucial role making sure everything works just right!

DIFFICULTY RATING = ⚡⚡⚡

TIME FRAME = 30 MINS

Electroscope

ACTIVITY 4

Students will learn how static electricity works and affects other objects through electrostatic induction.

They will make their own electroscope to detect static electricity.

EQUIPMENT

Clear plastic cup (or glass jar)
Piece of stripped wire 30cm long
Foil
Straw
Card (or cardboard)
Blu tack
Tape
Pencil
Scissors
An inflated balloon per pair
Empty metal drinks can (optional)

OPTIONAL EXTENSION:

Dryer sheets

METHOD

- To start, either demonstrate or allow students to explore static electricity. Charge the balloon with static electricity (rub it on a woolly jumper or hair) then: stick the balloon to the wall, raise partner's hair, attract a rolling can. Discuss with students what is happening in each activity and why.
- In pairs, students build their own electroscope to detect static electricity.
- First cut a cardboard lid the same size as the cup and use a pencil to make a hole in the centre for the straw. Cut the straw to be 5cm long and push it halfway through the hole, using the blu tack to fit the straw in place.
- Twist one end of the wire into a spiral shape, and put the other end through the straw. There should be about 2cm sticking out of the bottom of the straw. Bend this into a small hook.
- Cut out 2 drop-shaped pieces of foil, about 3cm long, and making a small hole, hang these off the hook so they are touching each other.
- Finally, stick the lid on. The foil should hang free, not touching the bottom of the cup.
- Students then test the electroscope by moving an uncharged balloon towards the spiral, then a charged balloon. The foil pieces should move away from each other. Then discharge the static electricity on the balloon by touching it to something metal and test it again.

QUESTIONS FOR STUDENTS

What is static electricity? How is it generated?

What are the dangers of static electricity and why do we need to be able to detect it?

Why does the electroscope detect the static electricity even when it does not touch the wire?

KEY SKILLS

EXTENSIONS

- Dryer sheets are designed to reduce static electricity in your tumble dryer. Ask students to investigate whether they work using their electroscope.

ENRICHMENT

CHECK OUT -
www.bit.ly/electroscope-enrichment-1
Learn the dangers of static electricity in aircraft

RELATED CAREERS

Aerospace Engineer

Designs, tests, builds and maintains planes, spacecraft and satellites. When designing aircraft they try to eliminate or reduce the electrostatic charge built up during flight.

Project Manager

Helps plan, organise, and guide a team to make sure the project is successful from start to finish.

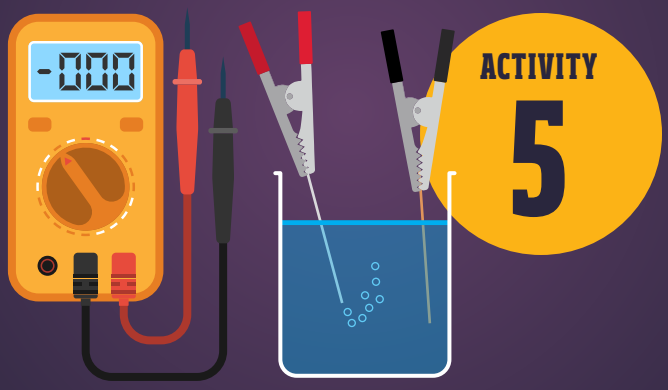
DIFFICULTY RATING = ⚡⚡⚡⚡

TIME FRAME = 30 MINS

DIY Battery

Students will learn about how chemical reactions generate electricity in a battery.

They will create their own saltwater and fruit batteries and measure the voltage.



EQUIPMENT

500ml plastic or glass beaker

Copper electrode (or copper coin)

Zinc electrode (or galvanised nail)

Salt

Water

Spoon

Wires for crocodile clips x 3

Voltmeter

OPTIONAL EXTENSION:

Coke or other fizzy drinks

Variety of fruit and vegetables
(e.g. pear, apple, lemon, potato)

QUESTIONS FOR STUDENTS

What different types of batteries exist? What do they have in common and how are they different from each other?

What chemical reaction do you think is happening between the electrodes and the salt-water?

METHOD

SAFETY NOTE: This activity includes electrical equipment and water. Please ensure students are aware of the safety requirements and are well supervised.

- Students follow the instructions to create a saltwater battery.
- First make salt water by mixing 10g of salt into 200ml water until it dissolves.
- Insert the copper and zinc electrodes into the saltwater electrolyte, making sure that they are not fully submerged. They must not touch each other or this will create a short-circuit.
- Create a circuit by connecting each electrode to a crocodile clip and then to the voltmeter. The crocodile clips must not enter the water.
- Students can then measure the potential difference of their battery using the voltmeter.
- Ask students to observe the zinc electrolyte: they should notice bubbles.

KEY SKILLS

EXTENSIONS

- Allow students to explore other homemade batteries.
- They can replace the saltwater with coke or other fizzy drinks and measure the voltage.
- Students can also make batteries by inserting the electrodes into different pieces of fruit or vegetables and measuring the voltage. They need to make sure that the electrodes do not touch inside the fruit.

ENRICHMENT

CHECK OUT - **www.bit.ly/sodium-ion-batteries**

Learn about the sodium-ion batteries of the future

RELATED CAREERS

Chemical Engineer

Develops the process to transform raw materials into useful items, such as making plastic from oil or producing new kinds of fabrics.

Energy Engineer

Finds innovative new ways to meet the planet's energy needs and works towards zero carbon emissions.

DIFFICULTY RATING = ⚡⚡⚡⚡⚡

TIME FRAME = **30 MINS**

Hi, I'm Michael. I joined BAE Systems at 18 as an Electrical Higher Apprentice in Maritime Services.

Now in my third and final year, I am currently an Apprentice Project Engineering Manager for the Queen Elizabeth Class Carriers. In short, I help to answer any questions regarding work that has been drawn and planned. This includes jobs such as tracing cables from one side of the ship to the other or finding alternative materials if one becomes obsolete. During my apprenticeship, I've had a wide range of experience within the company from working out the health, safety and environmental factors of autonomous boats to helping maintain the radars on top of the carriers.

Moving from placement to placement, I have realised the importance of teamwork and communication. Whether I was office based or in a role outdoors, there have always been jobs that require the skills of more than one person.

Hi! I'm Hannah, Head of Sustainability at BAE Systems.

I first joined BAE Systems Air as a summer intern when I was 21, then went back to university to complete my masters and re-joined the following year as an Engineer on the Graduate Programme. I have had an amazing time working on lots of different engineering projects and have been lucky enough to travel and experience different cultures as part of my job. I'm now Head of Sustainability, which involves setting out strategy and approach while connecting teams across the business to deliver across our Environment, Social and Governance commitments.

To succeed in my role teamwork is essential. Sustainability is something that affects everyone and in such a big company we have to work as a team to make change. It's an opportunity for us all to work together, share knowledge and learning to accelerate us on our sustainability journey.

www.baesystems.com/apprentices • www.rafyouthstem.org.uk • www.raf.mod.uk/recruitment/apprenticeships

WHERE DO YOU GO FROM HERE?

STUDYING AT SCHOOL

There's loads more to learn about electricity – far more than we have had time to cover here. All areas of science cover energy, especially physics, which explores electricity in more depth.

APPRENTICESHIPS

You can do an engineering apprenticeship once you're 16 or older. This gets you right into the wider world, learning everything from how to service an RAF aircraft to writing the software that guides the Royal Navy aircraft carrier underneath it.

A-LEVELS, SCOTTISH HIGHERS & T-LEVELS

Being 16 years old might feel like a long way away, but that doesn't mean you can't plan for it. Engineering, Physics, Maths, and even Chemistry, are great choices if you want to be an Engineer.

DEGREES & DEGREE APPRENTICESHIPS

Degrees, just like apprenticeships, will give you a wider view of the world, focusing more on the theory. Degree apprenticeships are a blend of the two: you have a hands-on job and also do university work.

Throughout the activities, you've seen just a few of the careers connected with electricity. There are so many more...

We hope you learnt a lot about electricity.

Engineers use all of these skills. If you enjoy solving problems, being creative, or working as a team, maybe you'd like to be an Engineer.

Ravenscroft, T.M. (2020), Skills Builder Universal Framework of Essential Skills, London: Skills Builder Partnership at **www.skillsbuilder.org/framework**

If you enjoyed these activities, why not try our Magnetism and Space resources, found here:

www.bit.ly/SR-2022-MAGNETISM • www.bit.ly/SR-2023-SPACE

www.baesystems.com/learninghub