ELECTRICITY

A collection of experiments investigating electricity and chemical reactions

Curriculum Links

Sc1 Testing ideas, planning investigations, observing & measuring
Sc4 Understanding electricity, simple circuits & drawing circuit diagrams
Sc3 Characteristics of materials, changing materials & chemical reactions

Summary of Experiments

General Format: *Four experiments for the whole class (in 6 small groups) or as a carousel, plus a small group / demonstration experiment*

- ELECTRICAL CIRCUITS ~ construct circuits with batteries & lamps
- COMPARING CONDUCTIVITY ~ test different solids & liquids
- POTATO POWER ~ build a circuit to run a clock without batteries
- ELECTRO-PLATING ~ use electricity to drive a chemical reaction
- SPLITTING WATER ~ observe a chemical reaction driven by electricity

Health & Safety Considerations

ADULT SUPERVISION REQUIRED

NO EATING OR DRINKING IN THE LABORATORY
ALWAYS WASH YOUR HANDS AFTER USING CHEMICALS

THROUGHOUT: WARN PUPILS OF THE DANGERS OF MAINS ELECTRICITY. THEY SHOULD NEVER INVESTIGATE OR PLAY WITH MAINS SOCKETS & ELECTRICAL EQUIPMENT.

EMPHASISE THAT THE WORK THEY DO IN CLASS IS SAFE BECAUSE THEY USE BATTERIES WHICH ARE MUCH LESS DANGEROUS.

PUPILS MUST BE WARNED NOT TO CUT OPEN BATTERIES OR SHORT-CIRCUIT THEM.

Box Development by: *Emma Gaylard, Westbury Park Primary School*

ELECTRICAL CIRCUITS

Construct simple circuits using batteries to power a lamp

Learning Objective: *To explore how circuits work and understand how to represent them in diagrams*

Resources provided in Box

- *6* AA Batteries (1.5V)
- *30* Lengths of wire (red & black)
- *6* Bulbs (1.2V)
- *6* Battery holders
- *60* Crocodile clips
- *6* Bulb holders
- *Set* Laminated circuit symbol cards (magnetic)
- *1* Battery tester
- *6* Multi-meters

Resources you need to provide:

- A selection of devices which use electricity, include a wind-up appliance if possible (e.g. torch, radio). Children could bring in toys.
- *Optional* – A long length of rope (4-6 mm diameter is ideal)

SAFETY

WARN PUPILS NOT TO SHORT-CIRCUIT BATTERIES OR CONNECT THEM DIRECTLY TO EACH OTHER

MAKE SURE DEVICES AND BATTERIES ARE MATCHED E.G. A 1.5 VOLT BULB NEEDS A 1.5 VOLT BATTERY

WHEN WORKING WITH A CIRCUIT ALWAYS CONNECT THE BATTERY LAST & DISCONNECT IT FIRST

(Batteries contain very corrosive chemicals. A 'short circuit' happens when two terminals of a circuit are accidentally connected together directly, without a bulb or meter etc in between. Short-circuited batteries can become hot and, if the case is pierced, chemicals can squirt out.)

Preparation:

- Test batteries to ensure they have sufficient charge

ELECTRICAL CIRCUITS

Introduction:

Discuss the toys & appliances – which have to be plugged in? Which use batteries? Can any work using both?

What about the wind-up device, where does that get its electrical power from?

~ Introduce the idea that electricity involves the movement of electrons (charged particles) through conducting materials.
~ This movement of electrons carries energy with it.
~ The energy carried by the electrons can be transferred to something else which uses that energy e.g. a bulb in the circuit.
~ A flow of electrons can be generated by converting another form of energy e.g. chemical energy in batteries, mechanical energy in the wind-up device.

Key vocabulary: Electricity, Battery, Circuit, Energy, Electrons, Charge

Experiment Method:

Work in small groups, each group needs a battery & holder, 5 lengths of wire & crocodile clips, a bulb & holder

→ Experiment with building circuits from the available components

→ Can you get the bulb to light?

(remind children that batteries should not be connected directly to each other)

Introduce symbols for different parts of the circuit

→ Can the pupils draw and label their circuit?

Extension Activity:

→ Can the pupils change the brightness of the bulb by changing different parts of the circuit (e.g. more/less batteries, wire, bulbs etc).

→ Use the meters to measure the voltage & current flowing through the different circuits

ELECTRICAL CIRCUITS

Discussion:

Which circuits worked and which didn't?
What components do you need for the most basic circuit?
Why is it important they only change one thing at a time when testing their circuits?
What are the symbols for different parts of the circuit

The Science Stuff:

How does energy get from the battery to the bulb? When the circuit is completed, charges in all parts of the circuit are set in motion simultaneously.

As the charges pass through the bulb, electrical energy (carried by the electrons) is changed into light energy which we can see.

It is helpful to separate the concept of energy from that of electrons/charge.

A useful analogy / activity is that of the rope loop

Use a long length of rope (4-6 mm diameter is ideal), which can be passed in a BIG loop around all of the pupils in the class.

→ Pupils stand in a big circle (you might carry out this activity in the school hall or outside) with their palms facing upwards.
→ The rope loop is passed out with each pupil allowing it to pass lightly over their curled fingers.
→ The teacher then starts to move the loop of rope round by passing it from hand to hand.
→ One pupil is instructed to grip the rope a little more tightly as it passes through their hand, and the teacher keeps the rope moving.

At this point (with the basic rope "circuit" set up) the teacher can start to pose questions about what is happening?

The key features of the analogy to establish are that:

~ the battery is represented by the teacher moving the rope
~ the bulb is represented by the pupil gripping the rope
~ the electric current (or moving charges) is represented by the moving rope
~ energy is shifted through working (due to friction) at the "bulb"

As in an electrical circuit a chemical energy store is being emptied (teacher as battery), and at a distance, something is getting that energy & warming up (pupil as bulb). So as in a circuit the rope (charge) moves around, transferring energy.

ELECTRICAL CIRCUITS

Comments & Tips:

Download a sheet of circuit symbols from TTS:
www.tts-group.co.uk/_RMVirtual/Media/Downloads/CHIPS.pdf

Download electronic versions of circuit symbols for use in Word, Powerpoint etc from The Electronics Club: www.kpsec.freeuk.com/symbol.htm

You could set the pupils a challenge to build circuits with different functions, e.g. a light which comes on when someone comes into a room.

{please add any useful tips about this experiment based on your experience}

Source: *IOP 'Supporting Physics Teaching, 11-14' , Electricity & Magnetism*
www.talkphysics.org
QCA Scheme of Work 4f , Circuits & Conductors
http://webarchive.nationalarchives.gov.uk/20100202164753/http://standards.dfes.gov.uk/schemes2/science/sci4f/?view=get

COMPARING CONDUCTIVITY

Test different solids & liquids to discover if they conduct electricity

Learning Objective: *To investigate conductivity of different materials through building a circuit & observing*

Resources provided in Box *(* equipment also used in other experiments)*

- *6* AA Batteries (1.5V) *
- *18* Lengths of wire (red & black) *
- *6* Bulbs (1.2V) *
- *6* Glass beakers
- *50g* Salt (in screw-top container)
- *100ml* 1M Acetic Acid (clear vinegar)
- *1* Battery tester *
- *2 litres* Distilled Water
- *6 sets* Solids to test (e.g. plastic pen, rubber eraser, pencil 'lead' (graphite), metal strip)
- *6* Battery holders *
- *36* Crocodile clips *
- *6* Bulb holders *
- *12* Copper electrodes
- *6* Plastic teaspoons
- *6* Plastic Pipettes
- *6* Multi-meters *

Resources you need to provide:

- *(Optional)* Other solid items to test

SAFETY

NO EATING OR DRINKING

NEVER TOUCH CIRCUITS & BATTERIES WITH WET HANDS

WARN PUPILS NOT TO SHORT-CIRCUIT BATTERIES

WHEN WORKING WITH A CIRCUIT ALWAYS CONNECT THE BATTERY LAST & DISCONNECT IT FIRST

Make sure devices and batteries are matched e.g. a 1.5 volt bulb + a 1.5 volt battery

Chemicals are LOW HAZARD, but Salt + Acetic Acid (Vinegar) will sting cuts

(If two terminals of a circuit are connected directly, without a bulb or meter etc. in between, they can 'short circuit', the batteries can become very hot and potentially leak corrosive chemicals.)

Preparation:

- Test batteries to ensure they have sufficient charge

COMPARING CONDUCTIVITY

Introduction:

Discuss where & how electricity moves in the world around us, for example in wires and circuits, but also in nature e.g. lightning strikes, when you get a static 'shock'.

Do the pupils think that electricity can move through all materials easily? Are all materials equally conductive?

Are there any 'insulating' materials which we can use to protect ourselves from electricity? (e.g. the plastic covering of wires, rubber-soled shoes)

How could we test whether materials conduct electricity or not? What kind of circuit would we need?

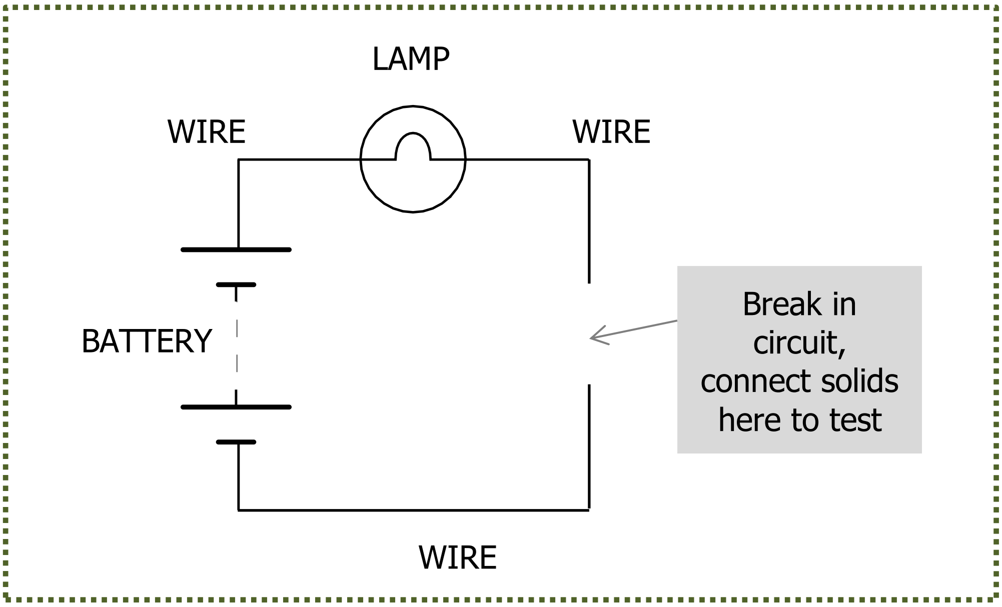
Key vocabulary: Electricity, Conductor, Insulator, Electrons, Ions

Experiment Method:

Testing Solids for Conductivity

Work in small groups, each group needs a battery & holder, 3 wires & clips, bulb & holder and selection of solid items to test

- → Build a simple circuit with a battery, 3 wires & a bulb, with a break between 2 of the wires
- → Using various solid items (such as a plastic pen, an eraser, graphite rod etc.) try to complete the circuit and see if the lamp lights

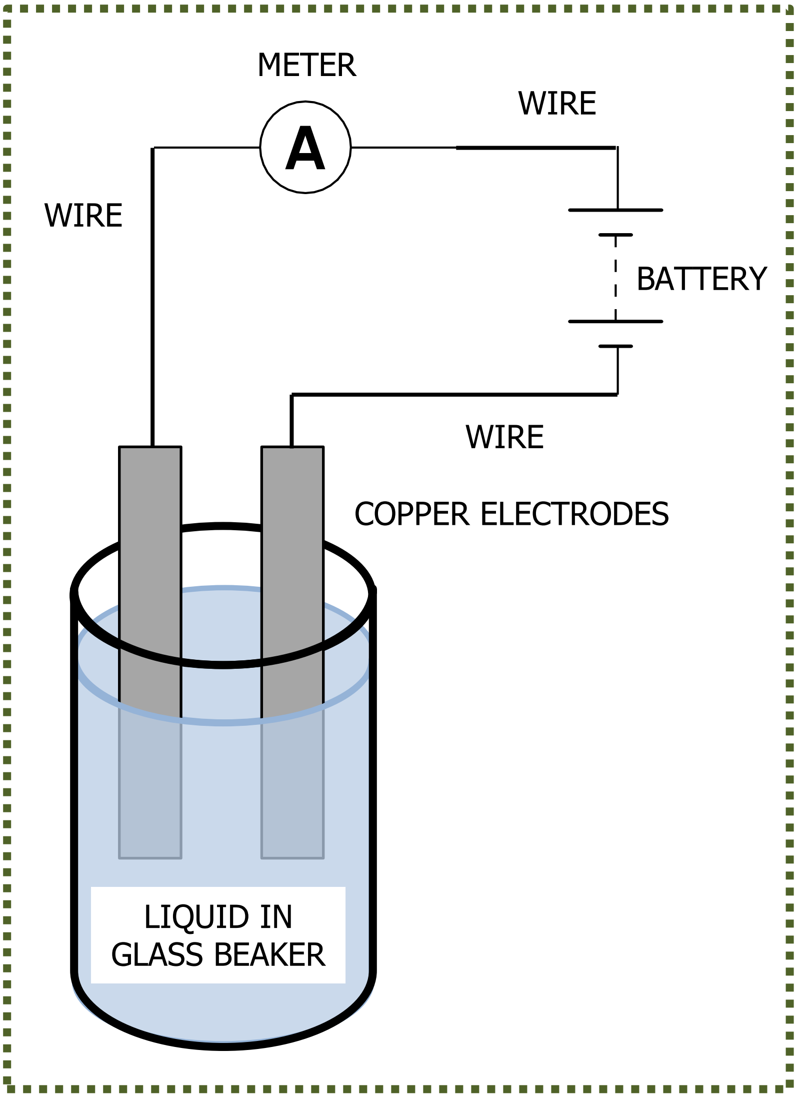


COMPARING CONDUCTIVITY

Testing Liquids for Conductivity

Work in small groups, each group needs a battery & holder, 3 wires with clips, meter, 2 copper electrodes & a glass beaker

- → Set up a circuit with a meter (instead of a bulb) and 2 copper electrodes
- → Set the meter to the microamp scale
- → Fill the beaker with distilled water and place the electrodes in the water
- → Be careful not to touch the electrodes to each other!
- → **Make sure your hands are dry**, then connect the battery - is there any reading on the meter?
- → Using a plastic teaspoon, add a small amount of salt to the water and stir very gently. Does the reading on the meter change?
- → Get some fresh distilled water and add a few drops of vinegar – watch the meter as you do so.



COMPARING CONDUCTIVITY

Extension Activity:

- → Use the multi-meter to compare the current flowing in the circuit with the different solids
- → Try using tap water in the liquid circuit, does that conduct more or less than the other liquids
- → What happens if you add more salt or vinegar to the water?

Discussion:

Which solids conducted electricity and which didn't? The former are known as *conductors*, the latter as *non-conductors*, or *insulators*.

Were any solids better conductors than others – how could you tell? (The graphite rod may cause the bulb to shine less brightly)

How did the current change with the different liquids?

Why do you think this might be?

Why should you be very careful around electricity when your hands are wet? (Many people have been killed by appliances like hair dryers when used around water, because it is a very good conductor of electricity.)

The Science Stuff:

Pupils should notice that metallic items cause the lamp to light while most others do not.

The graphite rod (also known as the 'lead' from a pencil) allows the bulb to light although perhaps not as brightly, depending on how long or short the graphite is.

This is because the graphite presents a certain amount of resistance to the flow of electricity. There are many solid materials that have intermediate properties between conductors and insulators, like graphite.

COMPARING CONDUCTIVITY

How does electricity flow in a solid? In metals, electrons are free and can move around inside, so they can flow and form a current.

Other materials, such as plastics, rubber and ceramics don't conduct electricity, because the bonds between the molecules inside them are different. The electrons are trapped and they can't move to make a current.

(The two types of bonding are known as *ionic* bonding and *covalent* bonding.)

In a liquid all the molecules can move around anyway, so if the molecules are charged (known as *ions*) then they can flow and form a current.

Salt makes water more conductive. Kitchen salt consists of sodium and chlorine molecules (NaCl). The water not only separates the salt molecules one from another, but also separates the chlorine and sodium from each other and the sodium gives up one electron to the chlorine. They have become ions – the sodium becomes positively charged (Na^+) and the chlorine becomes negatively charged (Cl^-).

The molecules of many salts & acids (like vinegar) become ions when dissolved in water. They dissociate into particles of opposite charges. This type of solution is called an *electrolyte*.

If you add more salt to the solution the meter indicates increased current flow. The conductivity of a solution is proportional to the concentration of ions in the solution.

Comments & Tips:

{please add any useful tips about this experiment based on your experience}

Source: *Fun Science Gallery 'Conductors'*
www.funsci.com/fun3_en/electro/electro.htm#1

POTATO POWER

Build a simple circuit to run a clock ~ without batteries!

Learning Objective: *To understand what a battery is & how it works and to investigate alternative sources of electrical power*

Resources provided in Box *(* equipment also used in other experiments)*

- *6* Low-voltage LED clocks
- *12* Galvanised nails
- *18* Lengths of wire *
- *36* Crocodile clips *
- *6* Multi-meters *

Resources you need to provide:

- Potatoes (and other fruit, if using) ~ 2 per group
- 1p or 2p coins ~ 2 per group

SAFETY

NO EATING OR DRINKING
WASH HANDS AT END
DISCARD VEGETABLES/FRUIT AT END

PUPILS MUST BE WARNED NOT TO CUT OPEN BATTERIES
NOR TO INVESTIGATE OR PLAY WITH MAINS SOCKETS & ELECTRICAL EQUIPMENT

Preparation:

- Ensure the galvanised nails still have some zinc coating

POTATO POWER

Introduction:

Put up a picture of battery.

Why are batteries useful – what kinds of equipment are powered by batteries?

Discuss what pupils know about batteries & how they work.

- ~ Explain that a battery changes stored chemical energy into electrical energy
- ~ Batteries have two end electrodes, one is positive (+) and the other is negative (-) and the electrolyte, which separates the electrodes.
- ~ The electrolyte is something (usually a liquid) that conducts (allows the flow of) electrical charge between the positive & negative electrodes.
- ~ When a device is connected to a battery - a light bulb or an electric circuit - chemical reactions occur on the electrodes that create a flow of electrical energy (electrons) to the device.

Think about whether there is anything else that might work in the same way as the electrolyte inside a standard battery.

Explain the potato conducts electricity by providing a conductive liquid (electrolyte) that completes a circuit.

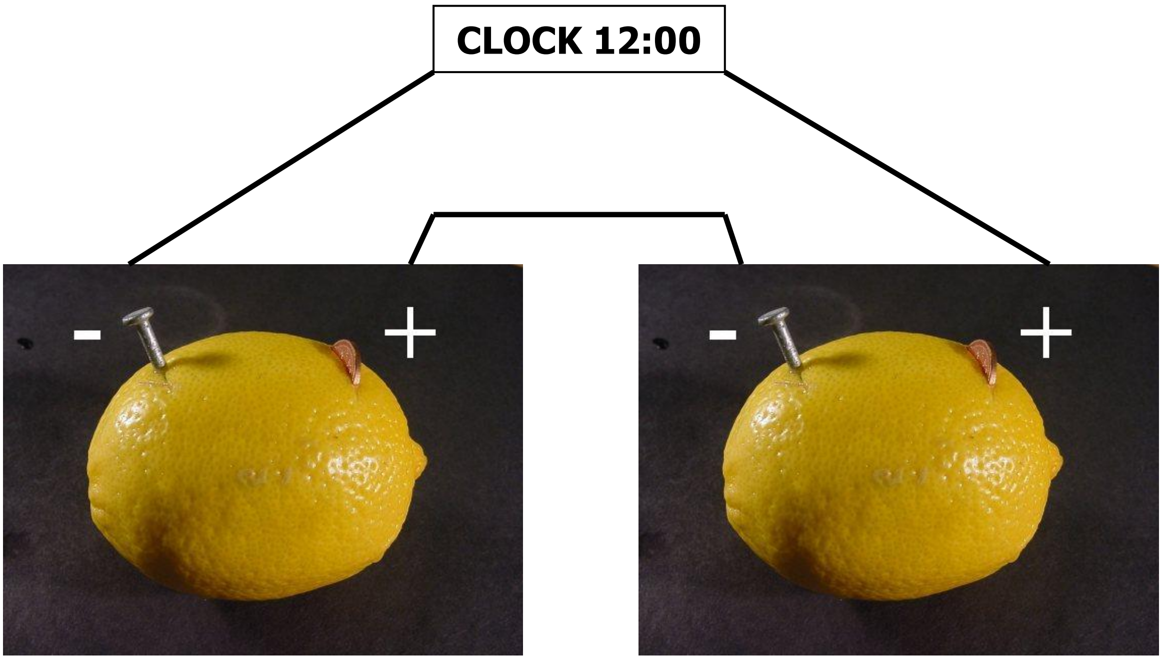
Key vocabulary: Battery, Circuit, Energy-(chemical & electrical), Electrons, Ions, Electrode, Electrolyte, Conductivity, Galvanised

Experiment Method:

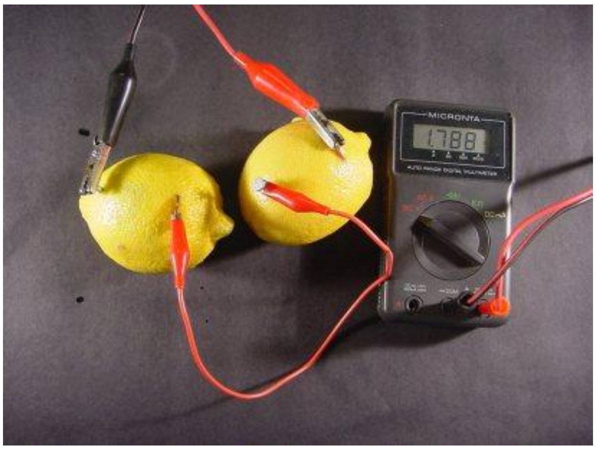
Work in small groups, each group needs 2 potatoes, 2 coins, 2 nails, 3 short lengths of wire, 6 alligator clips & 1 clock

- → Stick a nail and a coin into each of the potatoes so they are not touching each other (put them on the opposite sides).
- → On the first potato attach a wire to the nail and another wire to the coin.
- → On the second potato attach a third piece of wire to the coin.
- → Connect the wire from the coin on the first potato to the nail on the second potato.
- → Touch the free ends of the wires to the digital clock. (You may have to try connecting the wire to the clock in different ways to get the electricity flowing though the clock in the right direction).
- → Set the time!

POTATO POWER



Lemon version from HilaScience:
www.hilaroad.com/camp/projects/lemon/lemon_battery.html



Extension Activity:

→ How long will your clock run for?
→ Will the clock run with any other kinds of fruit or vegetables?
→ Use the meters to measure the current & voltage produced in the circuit

POTATO POWER

Discussion:

Draw a labelled diagram of your potato clock
How long did your clock run for?
Why do you think the clock stops eventually?
Did the clock work with other fruit or vegetables?

The Science Stuff:

NB. Strictly speaking a single cylindrical 'battery' on its own is a 'cell'. Two or more cells make a battery. In this experiment we have made 2 cells and connected them together.

In the potato clock the galvanised nail (covered in zinc) forms one electrode, the copper coin the other.

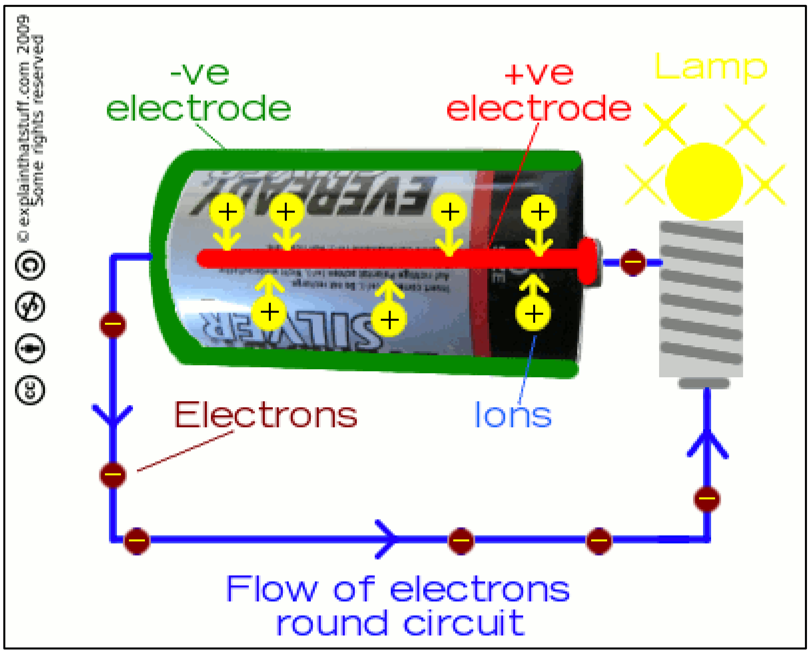
When the zinc nail comes into contact with the acid in the potato a chemical reaction occurs, releasing electrons. This is the negative (-) electrode. These flow through the wire to the copper coin where, at the same time, another chemical reaction occurs, which uses electrons. This is the positive (+) electrode.

Electrons are negatively charged, when they are made in the chemical reaction, they leave behind positively charged ions. These flow to the positive electrode where they combine with the electrons arriving to complete the circuit.

The acidic juice inside the potato is the electrolyte which conducts the ions between the 2 electrodes.

Batteries eventually lose their charge because the chemical reactions change the electrodes so that eventually they cannot supply any more electrons.

POTATO POWER



From: www.explainthatstuff.com/batteries.html

Comments & Tips:

You may be able to get away with one potato/piece of fruit per group by cutting it in half.

If using lemons or other citrus fruit, roll them firmly with the palm of your hand on a table or other hard surface in order to break up some of the small sacks of juice within the fruit first.

The potatoes (& other fruit) only produce a very low voltage, so are not powerful enough to light a bulb. You may be able to use the circuit to power any small devices which use an LCD display (e.g. a thermometer) as these kinds of displays only consume small amounts of power.

Source:

Fun Science Gallery 'Lemon Battery'
www.funsci.com/fun3_en/electro/electro.htm#2
Explain That Stuff! 'Batteries'
www.explainthatstuff.com/batteries.html

ELECTRO-PLATING

Use electricity to drive a chemical reaction and turn copper coins silver!

Learning Objective: *To investigate how electricity can change materials*

Resources provided in Box *(* equipment also used in other experiments)*

- *500ml* Acetic Acid 1M (clear vinegar)
- *100g* Epsom Salts (Magnesium Sulphate)
- *150g* Sugar
- *100g* Salt

- *6* Galvanised (zinc-coated) nails
- *6* Plastic measuring cylinders (100ml)
- *6* 1.5-volt "D" cell batteries & holders
- *12* Wires with Crocodile Clips *
- *6* Plastic bowls
- *6* Plastic teaspoons
- *6* Steel screws
- *1* Battery tester *

Resources you need to provide:

- Copper Pennies – new, shiny ones are best (otherwise clean beforehand using toothpaste & old toothbrush)

SAFETY

NO EATING OR DRINKING
NEVER TOUCH CIRCUITS & BATTERIES WITH WET HANDS
WARN PUPILS NOT TO SHORT-CIRCUIT BATTERIES

WHEN WORKING WITH A CIRCUIT ALWAYS CONNECT THE BATTERY LAST & DISCONNECT IT FIRST

Chemicals are all LOW HAZARD – but Epsom Salts are a laxative, Salt & Acetic Acid will sting cuts

CLOSELY SUPERVISE PUPILS TO ENSURE THEY DO NOT EAT OR TASTE CHEMICALS

(If two terminals of a circuit are connected directly, without a bulb or meter etc. in between, they can 'short circuit', the batteries can become very hot and potentially leak corrosive chemicals.)

ELECTRO-PLATING

Preparation:

- Test batteries to ensure they have sufficient charge
- Clean dull pennies with toothpaste to make them shiny ~ brush toothpaste on and rinse off ~ pupils could do this OR see → An Extra Experiment

Introduction:

Compare the pennies & nails – what are the similarities & differences? What metals are they made out of?

How could you get a metal to stick to another metal?

If you have any plated items to show, you could discuss how the pupils think they might have been plated.

Key vocabulary: Galvanised, Electro-plating, Electrons, Ions, Charge, Positive, Negative, Reaction, Solution

Experiment Method:

Work in small groups, each group needs a bowl, nail, battery, 2 wires, penny, measuring cylinder & teaspoon.

→ Put 100ml of Acetic Acid (vinegar) in a plastic bowl

→ Place a galvanised nail into the Acetic Acid and let it sit for at least 15 minutes (preferably longer – 1 or 2 hours)

→ Add 10g of Epsom Salts (1 teaspoon) and 15g of Sugar (1.5 teaspoons) to the vinegar and stir well to dissolve

→ Take a shiny penny and connect a wire to it using a crocodile clip – connect the other end of the wire to the negative (-) electrode of the battery

→ Clip another wire to the nail and connect the other end to the positive (+) electrode of the battery.

→ Place the penny into the Acetic Acid solution. **Do not let it touch the nail!**

→ Within a few minutes, you should get a silvery coating on the penny. You can let the process continue for 10-30 minutes

→ Disconnect the battery from the penny and piece of zinc. Remove the penny from the crocodile clip and rinse in water.

Tip: If your coating is dull grey instead of silver, make sure you cleaned the penny really well. You can also try using a toothbrush and toothpaste to polish it gently.

! Don't use normal Salt in this experiment

ELECTRO-PLATING

Extension Activity:

→ You could try leaving the penny in the solution with no battery attached, to see if the plating reaction will happen at all without electricity.

→ Turn your "silver" penny 'gold'. Place it in a 175ºC oven for about 15 minutes. The zinc mixes or "alloys" with the copper and forms brass.

Discussion:

What did the Acetic Acid do? Have the nails changed at all?

Why does the penny turn silver?

Compare results – whose penny is most sliver?

Can the pupils draw a circuit or diagram to show what is happening?

The Science Stuff:

Galvanised nails are coated with zinc, the first step dissolves this zinc coating into the acetic acid, creating positive (+) zinc ions in solution. (This is a chemical reaction)

The penny is connected to the negative (-) electrode, so it becomes negatively charged (with electrons). This attracts the positive (+) zinc ions

A positive zinc ion plus a negative electron forms a neutral zinc atom, which sticks to the surface of the penny. Eventually a thin coating of zinc atoms forms.

Without the battery to provide a negative charge (electrons), the zinc ions wouldn't attach themselves to the copper penny, they would just stay floating around in solution, or will only very, very slowly plate.

The Epsom salt makes the solution more conductive and the sugar promotes a shiny finish. The sugar is a brightener that inhibits large crystal growth at the electrodes and allows even plating.

Using Epsom salt instead of table salt eliminates the possibility of producing chlorine gas during the plating process.

Only a small voltage battery is required, the plating will occur slowly and more evenly than with a high voltage battery.

Electro-plating forms a very thin layer of metal – no more than ½ a millimetre thick. Electro-plating is widely used to give metal objects a better appearance or to protect them from corrosion, wear, or rust. Tin cans, for example, are tin-plated steel; Jewellery is plated with gold or silver to make it more attractive and the shiny chrome trim on cars is chromium-plated steel.

ELECTRO-PLATING

*** An Extra Experiment:**

This experiment is really about chemical reactions, but it links in and provides some nice clean pennies…

Shiny Pennies

→ Mix ½ a teaspoon of salt and 25ml of Acetic Acid in a bowl and stir until the salt dissolves.

→ Dip a dirty penny halfway into the liquid and hold it there for 10-20 seconds. Remove it from the liquid. What do you see?

→ Put that penny and another 2 dirty ones into the liquid. The cleaning action will be visible for several seconds. Leave the pennies in the liquid for 5 minutes.

Note: You want to keep the liquid you used to clean the pennies, so don't pour it down the sink!

→ Take one of the pennies out of the liquid and place it on a paper towel to dry.

→ Remove the other two and rinse them well under running water. Place them on a second paper towel to dry.

→ Write labels on your paper towels so you will know which has the rinsed pennies.

→ After about an hour take a look at the pennies you have placed on the paper towels. What difference do you see?

Note: You can use one of the clean ones for the Electro-plating experiment.

Copper Plated Screws

→ While you are waiting for the pennies to do their thing on the paper towels, use the salt and vinegar solution.

→ Place a steel screw so that it is half in and half out of the solution you used to clean the pennies.

→ Do you see bubbles rising from the threads of the screw?

→ Allow 10 minutes to pass and then take a look at the screw. Is it two different colours? If not, return the nail to its position and check it again after an hour.

Discussion:

Compare & share results. What have you observed happening?
Think about where the copper is coming from and going to.
Show pictures of new/old copper roofs and statues e.g. Statue of Liberty

ELECTRO-PLATING

The Science Stuff:

Pennies get dull over time because the copper in the pennies slowly reacts with air to form copper oxide. Pure copper metal is bright and shiny, but the oxide is dull and greenish. When you place the pennies in the salt and vinegar solution, the acetic acid from the vinegar dissolves the copper oxide, leaving behind shiny clean pennies. The copper from the copper oxide stays in the liquid. You could use other acids instead of vinegar, like lemon juice.

Rinsing the pennies with water stops the reaction between the salt/vinegar and the pennies. They will slowly turn dull again over time, but not quickly enough for you to watch! On the other hand, the salt/vinegar residue on the unrinsed pennies promotes a reaction between the copper and the oxygen in the air. The resulting blue-green copper oxide is commonly called 'verdigris'. It is a type of patina found on a metal, similar to tarnish on silver. The oxide forms in nature as well, producing minerals such as malachite and azurite.

The copper that coats the screw comes from the pennies. However, it exists in the salt/vinegar solution as positively charged copper ions as opposed to neutral copper metal atoms. Screws are made of steel, an alloy primarily composed of iron. The salt/vinegar solution dissolves some of the iron and its oxides on the surface of the screw, leaving a negative charge. Opposite charges attract, but the copper ions are more strongly attracted to the screw than the iron ions, so a copper coating forms on the screw. At the same time, the reactions involving the hydrogen ions from the acid and the metal/oxides produce some hydrogen gas, which bubbles up from the site of the reaction - the surface of the screw.

ELECTRO-PLATING

Comments & Tips:

Wearing plastic gloves to handle the components so you don't get fingerprints, grease etc on the penny after cleaning can help the electroplating process. However, sometimes this hinders the children as they work.

You can copper-plate paperclips too, as well as screws!

{please add any useful tips about this experiment based on your experience}

Source:

Finishing.com, Electroplating -- How It Works
www.finishing.com/faqs/howworks.html
Los Alamos National Laboratory Newsletter
www.lanl.gov/orgs/pa/newsbulletin/2005/03/02/ZincPlatedPenny.pdf
Dr Jonas, Kidventure.tv
www.youtube.com/watch?v=LqJwrUEh6Ek
About.com Chemistry, Fun With Pennies
http://chemistry.about.com/cs/demonstrations/a/aa022204a.htm

SPLITTING WATER

Observe a chemical reaction driven by electricity and split water

(a demonstration or small group activity)

Learning Objective: *To observe how electricity can change materials*

Resources provided in Box *(* equipment also used in other experiments)*

- *1* 9V Battery
- *1* Glass beaker *
- *2* Lengths of wire *
- *10g* Epsom Salts (Magnesium Sulphate)
- *500ml* Distilled Water
- *10ml* Universal Indicator
- *1* Battery connector
- *2* Graphite rods
- *4* Crocodile clips *
- *1* Plastic teaspoon *
- 1 Plastic pipette

Resources you need to provide:

- Thin Cardboard (1 sheet)

SAFETY

NEVER TOUCH CIRCUITS & BATTERIES WITH WET HANDS
WARN PUPILS NOT TO SHORT-CIRCUIT BATTERIES

CARRY OUT IN A WELL-VENTILATED ROOM
ENSURE NO NAKED FLAMES OR SPARKS

Epsom Salts are LOW HAZARD – but are a laxative – **CLOSELY SUPERVISE PUPILS** TO ENSURE THEY DO NOT EAT OR TASTE CHEMICALS

Universal Indicator is HARMFUL & FLAMMABLE – **Only to be used by an ADULT**

WHEN WORKING WITH A CIRCUIT ALWAYS CONNECT THE BATTERY LAST & DISCONNECT IT FIRST

(If two terminals of a circuit are connected directly, without a bulb or meter etc. in between, they can 'short circuit', the batteries can become very hot and potentially leak corrosive chemicals.)

Preparation:

- Test battery to ensure it has sufficient charge

SPLITTING WATER

Introduction:

Think about water – what is it made up of? Discuss and share ideas.

Explain that water contains different particles or elements/atoms (2 atoms of Hydrogen & 1 atom of Oxygen), its chemical formula is H_2O.

Usually it is very difficult to split water, but by passing an electric current through it we can cause a chemical reaction and split it into its 2 parts.

Key vocabulary: Electricity, Electrode, Solution, Particles, Hydrogen, Oxygen,

Experiment Method:

In a small group or as a demonstration:

→ Cut a square or cardboard big enough to fit on top of the beaker.

→ Fill the beaker to just below the top with water.

→ Add 2 spoonful's of Epsom Salt to the in the beaker and stir well.

→ Carefully, push one of the graphite rods through the cardboard. About three cm away, do the same with the other rod.

→ Place the cardboard on top of the beaker so that the rods are in the water, at approximately the same level below the surface.

→ Using the wire, connect the first graphite rod to the negative terminal of the battery.

→ Connect the other rod to the positive terminal of the battery.

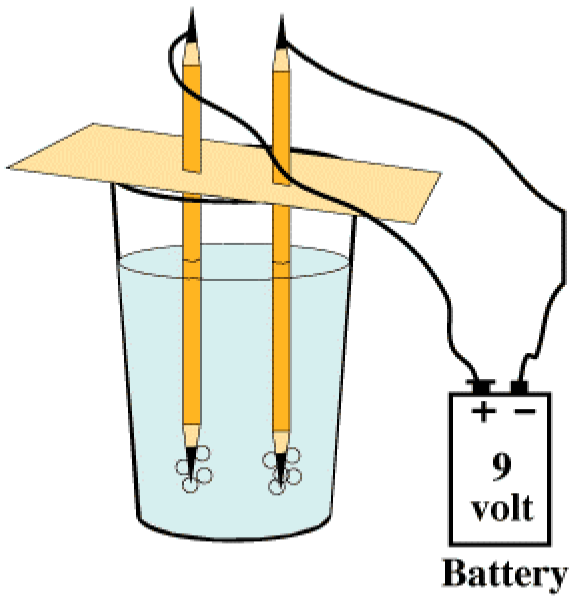
→ You should now have one rod (electrode) connected to the negative battery terminal and the other connected to the positive battery terminal. The non-connected ends should be submerged in the water.

→ Watch closely - bubbles should now begin to form on the two electrodes.

! The two gases formed are Hydrogen & Oxygen, which are flammable and even explosive.
Ensure there are no naked flames or sparks present.

(Disposal: flush the used solution carefully away in a drain, sink or toilet with lots of water)

SPLITTING WATER



Experimental set-up (with pencils instead of graphite rods)

From: Energy Quest 'Splitting Water' Science Project www.energyquest.ca.gov/projects/split_h2o.html

Extension Activity:

→ Add a few drops of Universal Indicator to the salt solution in the beaker & stir.
→ Leave for a little while so the liquid is still before putting the electrodes in.
→ As the reaction proceeds you should see a colour change around the electrodes. (from green to red at the positive electrode and from green to purple at the negative electrode)

Discussion:

What did you observe?
What do you think the bubbles are made of?
Are there the same amount of bubbles at each electrode?
Why did we add salt to the water first?
What do you think the changes in colour tell us?
Can you draw a circuit diagram to show how the electricity flows?

SPLITTING WATER

The Science Stuff:

This science behind this experiment is quite advanced and leads on to concepts such as atoms, molecules and chemical reactions. It may be best as simply an exercise in observation.

In the circuit the graphite is a conductor and the 2 rods act as the electrodes. Electric current from the battery flows from the negative terminal of the battery through the wire, through the water and back through the wire connected to the positive terminal.

You can refer back to the conductivity comparison experiment to discuss why salt is needed (it improves the conductivity of the water).

The electricity flowing through the salty water causes a chemical reaction to occur. This is known as *Electrolysis* (which just means any process that creates a chemical change in an electric cell).

The electric current splits the water into its 2 parts. The bubbles formed around the positive electrode are oxygen gas (O_2). The bubbles formed around the negative electrode are hydrogen gas (H_2).

You may notice more bubbles form around the positive electrode than the negative electrode. This is because of the chemical structure of water, H_2O. You get two hydrogen gas molecules for every one oxygen molecule.

The reason why the colour of the Universal Indicator changes is quite complicated for primary pupils, but it allows us to see easily that there is a chemical reaction taking place.

The green colour at the start indicates that the solution is neutral. An acid (indicated by the red colour) is formed at the positive electrode and a base (indicated by the purple colour) is formed at the negative electrode.

SPLITTING WATER

Comments & Tips:

You could use pencils instead of the graphite rods (but remove any metal parts & eraser first).

This experiment can be carried out using table salt (sodium chloride) instead of Epsom Salt. However, this produces Chlorine Gas, which can affect asthmatics. If you do it this way, ensure it is in a well-ventilated area and stop the experiment as soon as you notice a 'bleach' or 'swimming pool' type smell.

{please add any useful tips about this experiment based on your experience}

Source:

Energy Quest 'Splitting Water' Science Project
www.energyquest.ca.gov/projects/split_h2o.html
Try Science 'Got Gas?' Experiment
www.tryscience.org/experiments/experiments_electrolysis_athome.html
Nuffield Practical Chemistry 'Colourful Electroylsis'
www.nuffieldfoundation.org/practical-chemistry/colourful-electrolysis
YouTube 'Colourful Electrolysis
www.youtube.com/watch?v=wbgyJGlrUo8

Using the Battery Tester

Testing 1.5V batteries

→ Slide down the check handle.

→ Insert the battery to be tested between the display unit and the check handle, observing the correct polarity (+ and -), as shown in the diagram.

→ Push the check handle back to ensure good contact between the battery under test and the contacts on the battery checker.

→ Read the battery voltage and condition from the right-hand scale on the LCD display.

Testing 9V batteries

→ Press the contacts of the battery to be tested against the two contacts on the top of the battery checker, observing the correct polarity (+ and -), as shown in the diagram.

→ Read the battery voltage and condition from the left-hand scale on the LCD display.

Note: If you accidentally connect the battery to be tested the wrong way around, the display will show no reading. However, the battery checker will not be damaged by reverse polarity connection.

Using the Multi-Meters

Measuring Voltage (V)

→ Turn the dial to the V**–** 2 setting (top left hand section of dial)

→ Connect one wire into the COM socket and the other wire to the VΩmA socket

→ Connect the wires into the circuit in parallel

→ Read off the value in Volts (increase or decrease the range if required)

Measuring Current (A)

→ Turn the dial to the A**–** 2 setting (middle right hand section of dial)

→ Connect one wire into the COM socket and the other wire to the VΩmA socket

→ Connect the wires into the circuit in series

→ Read off the value in Amps (increase or decrease the range if required)

Note: If a minus sign appears before the reading, the polarity is reversed - switch the wires around.

Note: Don't switch the meter onto Current if you are measuring Voltage and vice-versa, it could short-circuit and damage the meter!