Introduction

This is a document about using modelling activities. The intended audience is teachers. Modelling will be an important strand of the KS3 Science Strategy and Framework. The *Electricity* resource on this CD ROM is an interactive electricity analogy to use with pupils.

Lesson outcomes

- Electricity concepts

Where the activity fits in

Any electricity topics

Skills

Knowledge and understanding, recall, vocabulary.

Acknowledgements

This document draws heavily on information from *Pathways Through Science: Electricity: Teacher's Guide*.

Pathways Through Science was a Longmans / Nuffield publication in the early 1990s but is now out of print.

Developing ideas in electricity

Models of electricity
Students will find it helpful to have a model to help them think about ‘electricity’. Without a model they can easily feel that electricity is abstract, inaccessible and just ‘too difficult’. You should encourage students to develop their mental models of electricity.

Students inevitably start with some conception of the nature of electricity. They should continually examine their models, and to develop more refined versions, appropriate to their own level of understanding. The model must be “good enough” to explain the concept they are thinking about, but they can modify it later.

The problem for teachers is to decide which model (or models) is or are likely to be most helpful to them. Teachers will have their own preferred explanations they may wish to use; they will also have their own, more sophisticated version which they may regard as ‘more correct’. It is important that a Science Department should discuss the models, reach a consensus and try to use the same models in all their teaching of electricity.

Presented here are several models of electricity, some at a higher level than others. These are outlined below, followed by some other ideas which teachers may find useful when students are looking for further ideas, or when they ask awkward questions.

A model is a good one if it allows students to solve problems at their own level. Any model is inevitably flawed, and will only be a partially true picture of reality. However, better a flawed idea which is understood than an over-elaborate idea which the student does not feel comfortable with.

Thinking about electricity
We talk loosely about ‘electricity’. Sometimes we mean the flow of electric **current**, at other times we mean something to do with electrical **energy**. It is important to separate these out.
Electric current flows all the way round the circuit – ‘the amps’.
Energy is carried round from, for example, the battery to a bulb – ‘the volts’.

This gives two basic levels for models to expand on this distinction:

- (at lower levels) current is the flow of electric charge round a circuit. An ammeter shows how much flows each second. The basic amount of charge is a coulomb.

Voltage is the push which makes electric current flow. It is provided by power supplies and cells. It is measured (in volts) using a voltmeter. The greater the push, the more energy the current carries.

- (at higher levels) current is the flow of charged particles round a circuit. (The particles may be electrons or ions). The particles are given energy by power supplies and cells; they give up their energy to bulbs, motors and so on. Voltage is a measure of the energy carried by the charged particles. A 1.5 v cell gives each coulomb of charge 1.5 J of energy.

Peas in a tube
We can picture the charged particles in a wire as being like peas filling a tube. Push an extra pea in at one end and another (different) pea falls out at the other end.

This model is useful as it explains the instantaneous effect of electricity. Of course electrons in a metal are not hard, round objects like peas. They influence their neighbours by electrical repulsion.

Gravitational models
We can picture a battery as a moving conveyor which raises electrical charges uphill to a higher level of electrical energy. Then as the charges travel round the rest of the circuit they run 'downhill', transferring energy to lamps and heaters.

We can draw a 'hill diagram' to show how a battery pushes the electric charges to a higher level of energy and how these charges then 'spend' the energy as they run down the various slopes to the bottom on their way round the circuit.
A ski-lift is a good model.

Water models
A model water circuit can also be helpful. We think of wires in a circuit as full of something that can be made to move (by a power supply or battery) just as water in a water circuit (such as a central heating system) can be made to flow by a pump.

This model fits with the idea of charge being a continuous, rather than a particulate, substance.
Students may already be familiar with the water cycle, and again this can be compared to an electric circuit. Solar radiation drives the cycle; a miller can transfer energy from the water as it runs downhill.

Fuel transport models
Some power stations are supplied direct by coal trains, direct from a coal mine. Coal may be burning within an hour of being cut underground.

In this representation the trucks represent coulombs of charge. They collect coal (energy resources) at the mine, and deliver it to the power station. Then return empty to the mine. If they didn’t return we would soon be in trouble!
We can use a similar model in which little people run around the circuit carrying sacks of coal. They empty their sacks at one point and run on for a refill. Some students like such ‘human’ models but others may regard them as childish.

Squashed up particles
Electrons are charged particles, and they repel one another. This is how the push from the supply is transmitted round the circuit at a speed approaching the speed of light.

We can think of the energy carried by the electrons as being stored amongst them. They are squashed together, as if there were springs between them. Students should be familiar with electrostatic repulsion if they are to understand this. The higher the voltage, the greater the degree of squash, and the greater the tendency of the particles to burst out of the power supply.

Making use of models
For students to derive any benefit from these models they must feel that they are useful. They must not feel that they are just another bit of stuff which they must learn because the teacher says so.

One way to approach any of these models is to ask students to evaluate them in a systematic way. You might ask:

- What forms the circuit in this model?
- What goes round the circuit?
- What represents energy in the circuit?
- Where does the current collect energy?
- Where does it give up energy?
- In what ways is this model similar to your own ideas about electricity? In what ways is it different?
- Which model is better?

A number of accessible models mean that there are plenty of opportunities for students to raise questions and suggest testable hypotheses, as required at higher levels of science investigations.

Fun Size: Electricity starters, middles and ends Teacher notes

Introduction

This is a statement sequencing activity in to produce sentences containing scientific facts. It is an ideal recap to a lesson or series of lessons, and is a good plenary activity.

Running the activity

The resource sheets consist of 20 beginnings, middles and ends to sentences. Print out the different sections on different coloured card, for example, white for beginnings, green for middles, blue for ends. Cut them into individual cards.

Pupils lay the white section out in a column and find the green middles and blue ends to go with each white starter. Do the activity against the clock.
It is useful if pupils work in groups of two or three. This gives a co-operative dynamic to the activity.

Safety

Not applicable.

Learning outcomes

- Reviewing pupil knowledge of electricity.

Where the activity fits in

Electricity revision

Skills

Knowledge, recall, sequencing.

Start

The unit of electrical current is

Start

The unit of electrical potential is

Middle

the amp. 1 amp of current is

Middle

the volt. There is 1 volt of potential difference when

End

one coulomb of charge per second

End

1 joule of energy is transferred by each coulomb of charge

Start

The **coulomb** is

Start

On a Christmas tree the lights

Middle

the unit of charge. One coulomb is

Middle

are wired in **series**. If one light goes out

End

600,000,000,000,000,000 (six hundred thousand million million) electrons

End

all the lights on the Christmas tree go out.

Start

In a house the lights are wired

Start

A **battery** is

Middle

in **parallel**. This means that if one light goes out

Middle

a packet of chemicals storing electrical energy. They react

End

all the others will stay on

End

to produce electrical energy

Start

As the current **flows round** the circuit, the total size of the current remains

Start

The **potential (voltage)** in a circuit

Middle

the same at all places in the circuit.

Middle

starts off at a maximum near the electricity supply. As you go round the circuit, the potential

End

Current does not get **used up** as electricity flows round a circuit.

End

decreases. This is because the electrical energy is transferred as the electricity flows round the circuit.

Start

The **law of energy conservation** says that energy can neither be created or destroyed. This means that

Start

'Energy' is just a way of explaining why things happen. The best way

Middle

you can only get as much electrical energy out of a battery

Middle

to think of energy is as **energy transfers.** When anything happens (such as a light bulb lighting up)

End

as there is stored chemical energy inside it. Batteries do not last for ever.

End

an energy transfer has to take place to make this happen..

Start

Stored energy is called **potential energy**. There are three

Start

Chemical potential energy is stored in **fuels.** Fuels can be burned

Middle

main types of potential energy: gravitational, chemical and elastic. The water held behind a dam has

Middle

to cause water to heat up and turn into high pressure steam. This is used to turn a turbine.

End

gravitational potential energy. This transferred as electrical energy by a hydroelectric power station.

End

The turbine powers a generator and chemical energy in the fuels is transferred as electrical energy for people to use.

Start

To connect an **ammeter** into an electrical circuit you must

Start

To connect a **voltmeter** into an electrical circuit you must

Middle

make a break in the circuit. Connect the ammeter across the gap and

Middle

connect the voltmeter across the two points in the circuit

End
all the electric current flows through the ammeter.

End
where you want to find the potential difference.

Start

Mains electricity in the UK is

Start

The device used to transfer movement energy to electrical energy is called

Middle

supplied to houses at 230 v a.c. You connect to mains electricity

Middle

a **generator or dynamo.** It consists of

End

using a 3-pin plug with a fuse in it.

End

a coil of wire which is made to spin quickly inside a strong magnetic field.

Start

Mains electricity is carried all over the country by a network of power cables called

Start

A simple device to generate electricity is a **bicycle dynamo**.

Middle

the **National Grid**. These carry electrical energy at a potential of

Middle

It consists of a magnet that is made to spin next to a coil of wire. The faster you pedal

End

230,000 v. This potential would kill you instantly if you touched the cables.

End

and spin the magnet, the brighter the lights on your bicycle will be.

Start

A 100w light bulb is very **inefficient** because

Start

When you pay for electricity your electric bill is calculated by finding

Middle

it only gives out 20w of light energy. The rest of the electrical energy transferred

End

heats up the surroundings a little and is wasted.

Middle

how many **Units** of electricity you have used through your electric meter. One Unit of electrical energy is

End

one kilowatt of power for one hour. So a 100w light bulb burning for 10 hours would use 1 Unit of electrical energy.

Fun-Size: Starting Electricity Bingo — Teacher notes

Introduction
This game is a revision activity to a lesson or series of lessons on early Yr 7 electric topics.

Running the activity
There are 50 cards, two to a page, all different. Print out as many pages as you need and cut them in half to make individual cards. Give out individual cards to each pupil. The cards can be laminated and a wax pencil used to mark them.

The teacher has the sheet of key word definitions. Mark or tick off the questions asked during each session. You may wish to substitute definitions targeted at your pupils. The definitions are read out and pupils have to recognise and cross off the key word on their card. The first pupil to cross off all the words on their card receives a small prize. Check the winning card with the class to focus on the words used in the activity. Pupils can write out any definitions they do not recognise.

For a blank file contact nigel.heslop@scienceyear.com

Safety
Not applicable.

More ideas
The questions can be used as the basis of a quiz. Key words could be displayed beside the teaching station. Sticky Velcro patches make a good support for the word display. There should only be a few key words to focus attention on the target vocabulary for that session.

Learning outcomes
- Simple vocabulary and ideas for early electric concepts

Where the activity fits in
Revising and consolidating
QCA SoW 7J

Skills
Vocabulary, recall skills.

✓ Tick these off when used in the session

Unit of electric potential:	Volt
Unit of electric current:	Ampere
This has to be complete for the electricity to work:	Circuit
Supplies the energy in a torch:	Battery
Colour of a positive connection:	Red
Colour of a negative connection:	Black
The brown wire in a 3-pin plug:	Live
Yellow-green wire in a 3-pin plug:	Earth
This melts if the electric current is too high:	Fuse
Colour of the neutral wire in a 3-pin plug:	Blue
Mains voltage in the UK:	230V (220V – 240V)
A safe voltage to use; a car battery voltage:	12V
The voltage of a single dry cell battery:	1.5V
Brown fuse for the 3-pin plug of a high power appliance:	13 amp
Red fuse for the 3-pin plug of a low power appliance:	5 amp
Killer voltage used for National Grid systems:	230,000V (220,000V – 240,000V)
Unit of electrical power:	Watt
The power of a bright light bulb:	150W
Used to measure the electric current:	Ammeter
Circuit where if one bulb goes out the others stay on:	Parallel

Electric Bingo Card

Volt	Ampere	Circuit		
Black		Earth		Blue
230V	12V		13 amp	
230,000V			Ammeter	Parallel

Electric Bingo Card

Volt	Ampere		Battery	
Black			Fuse	Blue
230V	12V			5 amp
	Watt	150W	Ammeter	

Electric Bingo Card

Volt	Ampere			Red
	LiVe	Earth	Fuse	
230V		1.5V	13 amp	
	Watt	150W		Parallel

Electric Bingo Card

Volt		Circuit	Battery	
	LiVe	Earth		Blue
230V		1.5V		5 amp
	Watt		Ammeter	Parallel

Electric Bingo Card

Volt		Circuit		Red
	LiVe		Fuse	Blue
230V			13 amp	5 amp
		150W	Ammeter	Parallel

Electric Bingo Card

Volt			Battery	Red
		Earth	Fuse	Blue
	12V	1.5V	13 amp	
230,000V	Watt	150W		

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230,000V	Watt		Ammeter	

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