Electricity: Structured Challenges

Health & Safety:

Teachers always need to risk assess practical activities for their children and defer to their health and safety advisor for the most up-to-date source of health and safety guidance.

This training cannot be relied upon as source of health & safety guidance.

Safety Talk:

It is important that a short safety talk is given every time the topic of electricity is introduced in the primary classroom. There is no reason for the pupils to be scared because the cells we use are low voltage, but they need to know that mains electricity is a very different matter and that car batteries can give a nasty shock too.

The Challenges:

Electricity is ***best*** delivered in a structured discovery/problem solving mode. Sometimes such inquiry-based learning is viewed as slack, but there is clear evidence that, done well, it enables the pupils to undergo deep learning. The tasks must be well structured, so that there is logical progression.

These challenges are set out logically to enable that progression and ideally are given to each pupil individually if there is enough equipment, or otherwise in pairs but do be careful that no child dominates and that the pairs work collaboratively.

Cell or battery? Cell is singular and battery plural, so more than one cell makes a battery. Battery is the commonly used everyday word and some batteries we buy have more than one cell inside them, whilst others don't. The National Curriculum uses 'cell', so it best we do too. Do explain this to them though.

The equipment needs to work so the cells (batteries!) and bulbs need checking. Also make sure that the cells are the right voltage for the bulbs (too high and they will blow the bulbs) and that all the bulbs are identical. Bulbs have their optimum voltage marked on them.

Year 4

Challenge 1:

- Given a cell, wires with connectors on the ends and a bulb in a holder, make the bulb light.

Some will manage this quickly and others will take much longer. Some may look around at others for ideas, which is fine. An extension task for those who finish quickly is:

- Make the bulb light outside the holder.

This is much tricker – each bulb has a very thin wire (filament) inside it and the small bulbs we use in schools have one connector to the filament on the bottom and the other on the side metal casing. If you look closely, you can see that the bulb holders connect to these two different places.

Teaching time:

Now is a good time to draw out the fact that a complete loop, which is called a 'circuit', is needed for the bulb to light.

Challenge 2:

- Make a bulb light with just a cell, a bulb in a holder and cooking foil – no wires.

Challenge 3:

- Design a circuit which will test out which materials allow electricity to flow through them
  Take this tester around the classroom and try out as many materials as possible.

This is deliberately placed before switches have been introduced – the pupils are likely to work out that they need to leave a gap in the circuit in which they can add whatever they are testing and see if a bulb lights.

Teaching time

It is a very good idea for them to test all sorts of things and see if they can spot the pattern/generalisation – all metals conduct electricity. The vocabulary, 'conductors' and 'insulators', needs introducing.

The plastic covered wires we use might confuse them and it is good to cut one and strip the wire so that they can see the a metal is inside.

Challenge 4:

- Construct a switch, something which can be pushed or moved so that the electricity is turned on or off.

In a way, they have already done this to devise the tester in the previous challenge, by making a gap in the circuit for the material to be tested. However, you can give them some paperclips, drawing pins etc and ask them to design some switches where something can be pushed or moved to complete a circuit.

Teaching time

Relate this to switches in the classroom and their own homes.

Challenge 5:

- Try out the other components, such as motors and buzzers.

This needs to be quickly followed by the next challenge:

Challenge 6:

- What difference does it make if you change the way round you connect a bulb, a buzzer or a motor in the circuit?

Teaching time

It does not matter which way round a bulb is connected, but a buzzer has to be connected a certain way – the black wire nearest to the negative pole of the cell and the red nearest the positive end. The motor will turn the other way round when it is turned around in the circuit. It is good to explain that the cell gives a 'push' to the 'bits' of electricity that are moving round the circuit. Changing the way round the cell is connected changes the direction of the push. The buzzer is an electronic component and needs to be connected the 'right' way – too complicated to explain why.

Ultimate Challenge

An open-ended problem-solving task is ideal as a means of challenge and assessment. Here are some suggestions:

- Wire up the doll's house.
- Make a Morse code transmitter
- The opening of the cage door of Houdini, the hamster, will activate an alarm.

In each case, the pupils can present their product to the rest of the class in a Dragon's Den scenario to set out the excellence of their system. The recording can be via video or annotated photographs.

Year 6

The numbering of the challenges is maintained from the Year 4 content because some of the previous challenges can be revisited at the beginning of Year 6 to recap their understanding – it should not take long to do this because they will be familiar with circuits.

Challenge 7:

- Make a bulb light and draw your circuit in your book so that it is clearly recorded.

In order to complete this task, the children will, hopefully, spend time producing an artistic representation of their circuit. It is then a good time to show them that it is possible draw the

circuit in two seconds flat in a way which any other scientist in the world will understand. Thus, they are introduced to circuit diagrams and understand their value.

Challenge 8:

- Set up a circuit so that one bulb is lit with just one cell. Find out what happens to the brightness when another bulb is added within the loop of your circuit. Then add another bulb in the loop and see what happens.

A series circuit has all the components contained within one continuous loop and is all they need to know about at primary. Adding more bulbs in a series circuit increases the resistance of the circuit and the brightness of the bulbs reduces. Each time another bulb is added.

It is just possible that they will add bulbs in parallel, which produces very different results from adding them in series. Parallel circuits have more than one loop. Adding more bulbs in parallel does not change their brightness and the reason for this is complicated so if they do accidentally discover this, I suggest you say that this will be explained at secondary school, and encourage them to make sure that there is just one loop with all components contained within it.

Challenge 9:

- Use different cells in a circuit with one bulb. What difference do they make to the brightness of the bulb? Look at the cells/batteries and see what labels are on them.
- Repeat this but this time with buzzers, instead of bulbs.

Teaching time

You can introduce the word ‘voltage’ by encouraging them to look at the labels – they should see a relationship between the number in front of the V (Volts) and the brightness or loudness. A bulb connected to a 1.5 V cell will be dimmer than one connected to a 4.5V cell etc. Do test this out beforehand though and be careful - if the voltage is too big, the bulb or buzzer may blow! The voltage is a measure of the ‘push’ given to the electrons – the bits moving around the circuit.

Challenge 10:

- Use two cells in circuit. What happens to the brightness of a bulb? Try connecting the batteries different ways around. How many different ways can you find? What difference does it make to the brightness of the bulb?

Use 1.5V cells here or the bulbs will blow if they add too many in series!

Teaching time

More than one cell is a battery. Two cells can be connected together in different ways: if they oppose each other (plus end next to plus end, or negative to negative) they are 'pushing the bits of electricity in different directions, so in effect they cancel each other out and no current flows. If they are pushing in the same direction, the current is bigger and the bulb is brighter.

Challenge 11:

- Given them various circuit diagrams, and ask them to construct the relevant circuits.

A useful assessment task.

Challenge 12:

- Make circuit diagrams for someone else to set up and predict the brightness of the bulbs in that circuit. They will tell you if you are correct!

Ultimate Challenge

Once again, an open-ended problem-solving task is ideal as a means of a final challenge and assessment. Here are some suggestions:

- An alarm system needs to be developed so that a teacher's lunchtime snack cannot be moved without a buzzer sounding or a light coming on.
- The opening of the cage door of Houdini, the hamster, will activate an alarm.
- The king of a distant land owns a priceless jewel, which he wants to display safely. The king has called for his scientific advisers (the pupils) to design a suitable system for doing this.
- Make an alarm that warns when the food in a sheep trough has run out.

In each case, the pupils can present their product to the rest of the class in a Dragon's Den scenario to set out the excellence of their system. The recording can be via video or annotated photographs.