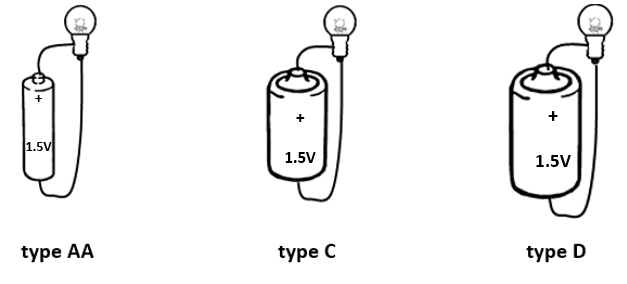
**1.5V batteries**

Some students are thinking about why there are different size batteries.

All of these batteries are 1.5 Volt. Each one is connected to a bulb.

And all the bulbs are exactly the same type.



Look at these statements.

For each statement, tick (✓) **one** column to show what you think about it.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Statement** | | I am **sure** this is correct | I think this is correct | I think this is wrong | I am **sure** this is wrong |
| **A** | All the bulbs will be the same brightness. |  |  |  |  |
| **B** | The biggest battery has more chemicals in it, so it will last longer. |  |  |  |  |
| **C** | The type AA battery has the most concentrated electricity, so it will have the brightest bulb. |  |  |  |  |
| **D** | The bulb on the type D battery will be brightest because it is the biggest battery. |  |  |  |  |

*Physics > Big idea PEM: Electricity and magnetism > Topic PEM1: Simple electric circuits > Key concept PEM1.3: Voltage*

|  |
| --- |
| **Diagnostic question** |
| **1.5V batteries** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | In an electric circuit energy is shifted from the chemical store of a battery to the moving charge, and from the moving charge to circuit components. |
| Observable learning outcome: | * Recognise that batteries are full of chemicals that are changed to make a circuit work. * Explain why bigger batteries last longer than smaller ones, of the same type and voltage, using the idea of a ‘chemical store’ of energy. |
| Question type: | Diagnostic, confidence grid |
| Key words: | battery, chemical store, moving charge, energy |

**What does the research say?**

To understand how a battery works in a circuit it is helpful to think of it as a chemical store (Millar, 2011). The chemicals in it are used up as they do work pushing electric charge around a circuit. Batteries with bigger voltages do work more quickly because they are pushing the electric charges harder. Most 11-14 year old students do not think of a battery in this way (Driver *et al*, 1994). In one study (Maichle, 1981) 340 out of 400 secondary school students in Germany thought of a battery as ‘storing a certain amount of electricity’ that was ready to flow round a circuit.

This misunderstanding can lead students to relating the physical size of a battery to its effect on a circuit. And this is perhaps reinforced by their experience of brighter torches using physically larger batteries.

**Ways to use this question**

Students should complete the confidence grid individually. This could be a pencil and paper exercise, or you could use an electronic ‘voting system’ or mini white boards and the PowerPoint presentation.

If there is a range of answers, you may choose to respond through structured class discussion. Ask one student to explain why they gave the answer they did; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs.

You may also wish to demonstrate the circuits to the class.

*Differentiation*

You may choose to read the questions to the class, so that everyone can focus on the science. In some situations it may be more appropriate for a teaching assistant to read for one or two students.

**Equipment**

For the optional demonstration:

* AA, C and D type batteries connected to identical 1.25V bulbs

**Expected answers**

A and B are correct, C and D are wrong.

**How to respond - what next?**

All the bulbs are the same brightness because each battery is 1.5V and gives the same sized ‘electrical push’.

As the battery pushes its chemicals are used up in doing work moving the electric charges (current).

Students selecting answer C as right are confusing electricity with a substance that can be stored. (It is the chemicals that are stored and react to make ions that push the current round – it is this moving current that is electricity.)

Students selecting answer D are again likely to be thinking of the battery as storing ‘something’ which pours out into the wires – and bigger batteries have more ‘something’ to pour out.

If students have misunderstandings about batteries being full of chemicals that get used up to make a circuit work, it may be useful to go back to the string loop model to challenge thinking and to tease out the correct scientific explanations. (Millar *et al* (2006) suggest that using the same model for electric circuits is more effective than trying to reinforce the learning with several different ones.)

Careful teacher questioning and discussion should quickly lead to an understanding that:

* The person being the battery is pushing the string round and the string (moving charge) is not pouring out of the battery!
* That after (a very long) time the battery will stop pushing because it will run out of food / fat / ‘chemicals’ that its muscles need.
* If the battery had less energy at the start (had not eaten for a week) it would run out of chemicals sooner.

Students could then be given the opportunity to express this in their own terms, or a chance to apply their scientific thinking to a new situation. In either case successful responses usually necessitate paired or small group activities and discussions, which encourage social construction of new ideas through dialogue.

*Extra information for teachers*

The reason brighter torches often have larger batteries is that they use a different bulb that needs a bigger current to work. To push the bigger current round the circuit, the chemical store in a battery will do work more quickly and its chemicals too will run out more quickly. Physically larger batteries are used because they have a bigger chemical store which means the torch won’t run out too quickly.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG), based on EPSE E05-003.

Images: EPSE and UYSEG

**References**

Driver R., Squires A., Rushworth P. and Wood-Robinson V. (1994). *Making sense of secondary science: research into children’s ideas* (pp.117-125). London and New York: Routledge.

Maichle, U. (1981) ‘Representation of knowledge in basic electricity and its use for problem solving’, in Jung, W., Pfundt, H. and von Rhoneck, C. (eds), *Proceedings of the International Workshop on Problems concerning students’ representation of physics and chemistry knowledge*, 14-16 September, Pedagogische Hochschule, Ludwigsburg, pp174-93.

Millar R., Leach J., Osborne J. and Ratcliffe M. (2006). Improving Subject Teaching, Lessons from research in science education. London and New York: Routledge.

Millar, R. (2011). ‘Energy, in Sang, D. (Ed), *Teaching secondary physics* (pp. 1-48). London: Hodder Education.