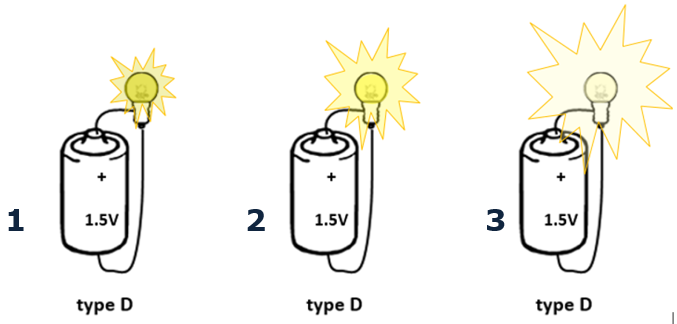
**Battery life**

Three different bulbs are lit with a battery.

The batteries are all exactly the same type.

1. Which battery will last the longest?

Put a tick (✓) in the box next to the correct answer.

|  |  |  |
| --- | --- | --- |
| **A** | Battery 1. |  |
|  |  |  |
| **B** | Battery 2. |  |
|  |  |  |
| **C** | Battery 3. |  |
|  |  |  |
| **D** | They all last the same time. |  |

* 1. Why will this battery last the longest?

Put a tick (✓) in the box next to the correct answer.

|  |  |  |
| --- | --- | --- |
| **A** | It is shifting energy from the battery the fastest. |  |
|  |  |  |
| **B** | It’s rating is 1.5V, the same as the battery. |  |
|  |  |  |
| **C** | All the batteries are the same. |  |
|  |  |  |
| **D** | It is shifting energy from the battery the most slowly. |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Battery life** |

**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: | * Describe how we know brighter bulbs shift energy from the chemical store of a battery at a faster rate. |
| Question type: | Diagnostic, two-tier multiple choice |
| 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 questions 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. The follow on question will give you insights into how they are thinking and highlight specific misunderstandings that some may hold.

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.

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.

**Expected answers**

1. A, b) D

**How to respond - what next?**

Answer A, D shows students have understood the idea that the less bright the bulb is, the slower it is shifting energy from the chemical store of the battery.

Answer D to part a: ‘all the batteries lasting the same time’ shows students thinking that the external circuit does not affect how the battery works. (It can’t push harder, but it can push faster, if there is less resistance in the circuit.) This is likely to be followed with answer C which confirms this thinking.

An answer of B, B shows a student is compounding the idea that a bulb works best at a particular voltage with energy efficiency.

An answer of C, A probably shows the student has understood the question wrongly and this may be a language problem. Other combinations of answers suggest guess-work.

If students have misunderstandings about how we know brighter bulbs shift energy from the chemical store of a battery at a faster rate, it may be useful it is 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 can only push so hard
* Different bulbs have different resistances to the push of the battery (gripping harder, or less hard) and the current flows through them at different speeds.
* If the battery is pushing the current faster, it will run out of chemicals (food) faster.
* When the battery is pushing faster there is more friction and more shifting of energy to the bulb.

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**

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