**Two different batteries**

|  |  |  |
| --- | --- | --- |
| **1.5V**  **+** |  |  |
| This bulb lights when it is connected to a 1.5V battery. |  | A 3V battery is then connected into the circuit, like this |

1. What will happen to the bulb?

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

|  |  |  |
| --- | --- | --- |
| **A** | It is lit – and brighter than before. |  |
|  |  |  |
| **B** | It is lit – similar brightness as before. |  |
|  |  |  |
| **C** | It is lit – but a lot dimmer than before. |  |
|  |  |  |
| **D** | It is not lit |  |

* 1. How would you explain your answer?

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

|  |  |  |
| --- | --- | --- |
| **A** | The two batteries together add to 4.5 V. |  |
|  |  |  |
| **B** | The two batteries together add to 1.5 V. |  |
|  |  |  |
| **C** | Current cannot pass through a battery in the wrong direction. |  |
|  |  |  |
| **D** | The bulb is connected to the positive terminal of both batteries, so there is no current through it. |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Two different batteries** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | The voltage, of batteries and power supplies, is a measure of their ‘strength’. |
| Observable learning outcome: | * Calculate the total voltage of combinations of different batteries in series. |
| Question type: | Diagnostic, two-tier multiple choice |
| Key words: | battery, voltage, volt |

**What does the research say?**

Driver *et al* (1994) suggest that to develop a good understanding of voltage, it is better, at this stage, to describe it as a measure of the strength of a battery’s ‘push’ – and a bigger voltage gives a bigger ‘push’.

These questions test if students have a clear understanding of voltage as an ‘electrical push’ and a bigger voltage as a bigger ‘electrical push’. It gives evidence that they can apply the concept beyond adding and subtracting identical 1.5V batteries, which is a task they could learn to do by simply adding the number of 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.

You may wish to set up these circuits on the bench to demonstrate the effect after students have given their answers.

Although 3V cells are not available, some teachers have set up a demonstration circuit to test students’ predictions after some discussion. To make the 3V battery they have connected two 1.5V batteries – and hidden these inside a labelled box (which is exactly what a 3V battery would be!).

*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 class:

* x4 1.5V batteries, x2 1.5V bulbs, 6 connecting wires

**Expected answers**

1. B, (b) B

**How to respond - what next?**

For part (a): answer A indicates the view that all batteries add to the brightness with no distinction to their polarity. Students giving this answer are likely to be thinking of each battery as a source of ‘electricity’ which moves out into the circuit to make the bulbs light. C shows understanding that the batteries are pushing in opposite ways, but not in a way that shows understanding of voltage as the size of the push. D suggests the student is linking the question to their experience of inserting batteries into a device the wrong way round and it not working.

For part (b): answer A confirms the response given to answer A in part (a). Answers C and D are different ways of explaining the experience of inserting batteries into a device the wrong way round and it not working. Answer C indicates students are thinking of the battery as part of the circuit, which is unlikely to be so for answer D.

If students have misunderstandings about calculating the total voltage of combinations of different batteries in series, it might be effective to model what is happening, or to give students practical experience in predicting and explaining measurements made when adding different batteries in series combinations. The following BEST ‘response activities’ could be used in follow-up to this diagnostic question:

* Response activity: String loop model (voltage)
* Response activity: Adding batteries (2)

With the string loop, students can model the role of the batteries in these circuits by pushing the string round in the directions indicated on the circuit diagrams.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG) from EPSE E2 Supplementary Q9

Images: EPSE

**References**

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