**Which is brightest?**

Three different batteries are used to light a bulb. Exactly the same type of bulb is used each time.

|  |  |  |
| --- | --- | --- |
| **1.5V** | **6V** | **9V** |
| **a** | **b** | **c** |

* 1. Which battery lights the bulb brightest?

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

|  |  |  |
| --- | --- | --- |
| A | Battery a |  |
|  |  |  |
| B | Battery b |  |
|  |  |  |
| C | Battery c |  |
|  |  |  |
| D | They are all the same brightness |  |

* 1. How would you explain your answer?

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

|  |  |  |
| --- | --- | --- |
| A | It has the most electricity in it. |  |
|  |  |  |
| B | It has the largest voltage, so it pushes the biggest current. |  |
|  |  |  |
| C | It is a torch battery and is designed to light bulbs. |  |
|  |  |  |
| D | Exactly the same type of bulb is used each time. |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Which is brightest?** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | The voltage, of batteries and power supplies, is a measure of their ‘strength’. |
| Observable learning outcome: | * Describe the effect of different battery voltages on simple circuits. |
| Question type: | Diagnostic, two-tier multiple choice |
| Key words: | battery, voltage, volt |

|  |  |
| --- | --- |
| **P** | **PRIOR UNDERSTANDING**  This diagnostic question probes understanding of ideas that are usually taught at age 5-11, to aid transition from earlier stages of learning. |

**What does the research say?**

Many researchers such as Driver et al (1994), Gott (1984) and Shipstone (1985) have found that students’ explanations, at an early stage, are likely to use the words current, voltage, electricity and energy to mean the same thing. To advance their understanding of electric circuits it is necessary for students to distinguish between: the current flowing through the circuit (that is conserved); the energy that is stored in the battery and then transferred elsewhere; and the voltage.

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’. In one study of 14-15 year old students in England, it was found that that 31% thought of voltage as something that flowed around a circuit (Shipstone, 1985). Driver *et al* (1994) note that embedding this clear distinction between current and voltage is a very important foundation for a clear understanding of electricity, and should be a focus of the learning at this stage.

**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 the circuits on the bench to demonstrate the effect after students have given their answers.

*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:

* 1.5V, 6V and 9V battery with a 9V bulb and connecting wires

**Expected answers**

1. C, b) B

**How to respond - what next?**

Choosing answer B, the 6V battery, suggest students are thinking of a battery as the store of electricity, which would be confirmed with choice A in the second part of the question.

Students choosing answer A, the 1.5V battery, followed by answer C are likely to be thinking of their own experience without an understanding of voltage.

Answer D followed by D shows students also thinking about what they have experience. This option suggests they are thinking about houselights. To get a different brightness of bulb at home you change the type of bulb, so the bulb determines the brightness. But this only works when the voltage is always the same – here we are looking at the effect of changing voltage.

If students have misunderstandings about how voltage affects the brightness of a bulb, it might be effective to model what is happening. The following BEST ‘response activity’ could be used in follow-up to this diagnostic question:

* Response activity: String loop model (voltage)

In the string loop model, stronger students who can push the string round harder have a bigger voltage. Like a marathon runner, over time they will use up all of their chemical store by pushing the string round.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG), from EPSE E05-004.

Images: EPSE

**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.

Gott R. (1984). *Electricity at age 15: a report on the performance of pupils at age 15 on questions in electricity*. London: Dept. of Education and Science, Welsh Office, Dept. of Education for Northern Ireland.

Shipstone, D.M. (1985). Electricity in simple circuits. In Driver, R. (Ed.), Children’s ideas in science (pp. 33-51). Milton Keynes: Open University Press.