**How a battery works**

The table contains statements about how a battery lights a bulb. Most of the statements are right, a few of them are wrong.

Use them to complete a **scientific explanation** of how a battery lights a bulb.

Start with:

The battery is …

|  |  |  |
| --- | --- | --- |
| Energy is shifted from the moving charge to the bulb. |  | The battery is a chemical store and is full of electricity. |
|  |  |  |
| The charge moves from the battery to the bulb. |  | The charge moves in all the circuit at once. |
|  |  |  |
| Energy is shifted from the chemical store to the moving charge. |  | And the bulb warms up – it gets white hot. |
|  |  |  |
| The battery is a chemical store because it is full of chemicals. |  |  |

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

|  |
| --- |
| **Diagnostic question** |
| **How a battery works** |

**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 the shift of energy from the chemical store of the battery to the moving charge (current); and from the moving charge to circuit |
| Question type: | Diagnostic, sequencing |
| 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**

This task is intended for discussion in pairs or small groups.

Students should read the statements and follow the instructions on the worksheet. Listening in to the conversations of each group will often give you insights into how your students are thinking. Each member of a group should be able to report back to the class.

Feedback from each group can be used, with careful teacher questioning, to bring out a clear description or explanation of the science.

*Differentiation*

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in the each group. For example, you may choose to select a student with strong prior knowledge as the scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

You may choose to leave out the two wrong statements for some students.

**Expected answers**

1. The battery is a chemical store because it is full of chemicals.
2. Energy is shifted from the chemical store to the moving charge.
3. The charge moves in all the circuit at once.
4. Energy is shifted from the moving charge to the bulb.
5. And the bulb warms up – it gets white hot.

Statements that are wrong:

* The battery is a chemical store and is full of electricity.
* The charge moves from the battery to the bulb.

**How to respond - what next?**

The correct scientific explanation shows students understand the physical processes that make the bulb light up.

Including the battery as being full of electricity shows a student is thinking of the battery as the place where all the electricity begins, before being released to flow round the circuit. Or they may be thinking of energy as a substance doing the same thing, with electricity and energy being interchangeable terms for many students talking about electricity.

Using ‘the charge moves from the battery to the bulb’ indicates this thinking again.

If students have misunderstandings about how a battery lights a bulb, 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 and the string (moving charge / electricity) is not flowing out of the battery!
* The electric charges are in the wires before the battery is connected and do not come out of the battery.
* The battery shifts energy from its chemical store (food) to the moving charge (string).
* The moving charge (string) heats up the hands of the bulb (through friction) – energy is shifted from the moving charge (string) to the hands.

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.

**Acknowledgments**

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**References**

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