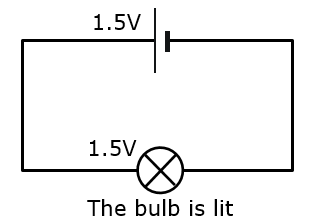
**Adding components**

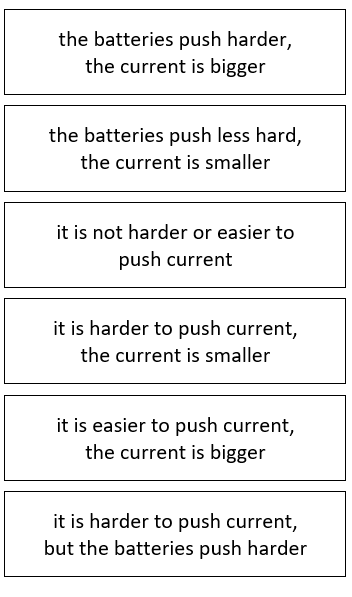
This circuit is set up and then components are added to see what happens.

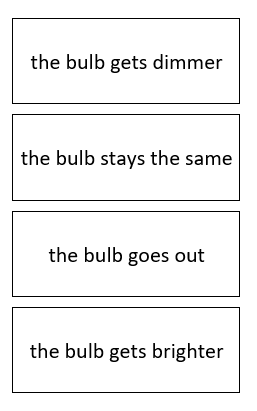
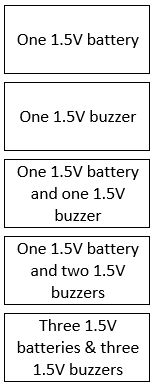


Join the boxes to explain what happens when components are added.

Draw one line from the added **component(s)** to **what happens**. Draw another line to **the reason**.







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

|  |
| --- |
| **Diagnostic question** |
| **Adding components** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Voltage is needed to push current through a component; and a particular voltage pushes just the right amount of current through a component for it to work well. |
| Observable learning outcome: | * Use the ideas of ‘electrical push’ and resistance to explain why adding components to a series circuit changes the current. |
| Question type: | Diagnostic, linking ideas |
| Key words: | voltage, current, resistance |

**What does the research say?**

The majority of students confuse ideas of voltage and current, typically they think of voltage as part of the current (Shipstone, 1985). 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’.

This activity gives students the opportunity to reflect on voltage of a battery as an ‘electric push’, and the voltage of other components as a measure of how hard the current must be pushed through them to make them work in the way they were designed to.

**Ways to use this question**

This task is intended for discussion in pairs or small groups. It is best done as a pencil and paper exercise.

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.

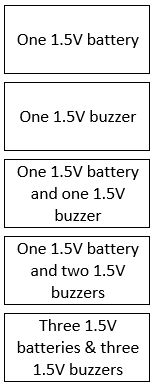
Feedback from each group can be used, with careful teacher questioning, to bring out a clear description or explanation of the science.

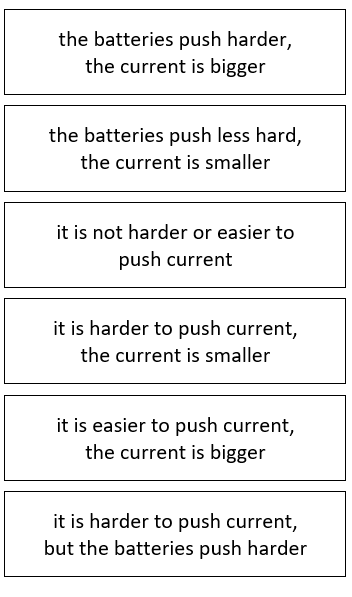
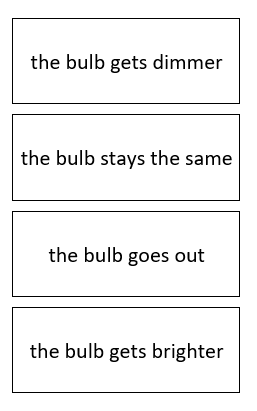
*Differentiation*

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.

NB in any class, small group discussions typically improve over time and a persistence with this strategy is often very successful in the medium to long term.

**Expected answers**

**How to respond - what next?**



Correct answers show students understand how batteries ‘push’ and how extra components make it more difficult for the battery to push the current round. Correct observations of the effect on the bulb also indicate students are linking the size of the current through the bulb with its brightness.

Students who see no change in brightness when adding a 1.5V buzzer are likely to be thinking the voltage marked on the buzzer simply describes the battery it needs. This view can come from experience of using electric devices, but ignores the rest of the circuit. The same thinking can lead students to predict the bulb will get brighter when equal numbers of batteries and buzzers are added.

The choice of ‘it is not harder or easier to push current’ as the reason for any prediction suggests the students are thinking of voltage as flowing round the circuit and being shared out between the bulb and the buzzers. (In response to adding one battery it is technically correct, but not the best answer.)

The choice of ‘the batteries push less hard’ suggests the battery is able to respond to the situation; and ‘it is easier to push current’ suggests students are mixing up their thinking with everyday language, as in the case: it was easier for her to lift the box because she is stronger.

If students have misunderstandings about using the ideas of ‘electrical push’ and ‘resistance’ to explain why adding components to a series circuit reduces the current, 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:

* Adding another battery pushes the string round more quickly and there is more friction at the ‘bulb’ so it is brighter.
* Adding a buzzer anywhere in the loop makes it harder for the battery to push.
* Adding a battery now will push the current faster – and the current can be increased back to what it was before.
* Adding a greater number of buzzers slows the current more, but pushing harder with more batteries can get it back to what is was at first.

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**

Developed by Peter Fairhurst (UYSEG).

Images: UYSEG

**References**

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

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