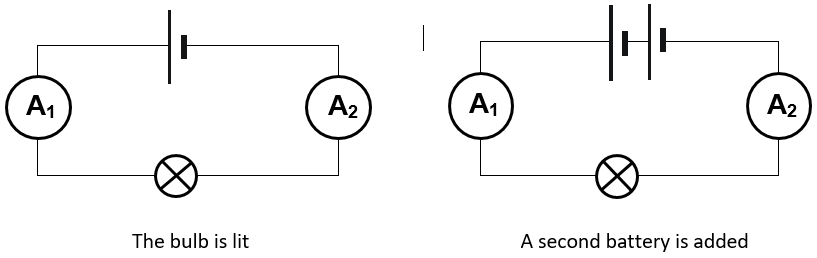
**Adding batteries (1)**

This practical activity is to find out what happens when you change the number of batteries in a circuit.

**Apparatus and materials**

* x2 1.5V batteries
* x1 2.5V bulb
* x2 ammeters
* x5 connecting wires

**Predict**

What do you think will happen when the second battery is added? What do you **predict** will happen to the readings on the ammeters?

**Explain**

Explain why you think this will happen.

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| **Now make the circuits and see what happens.** |

**Observe**

Describe what happens.

**Explain**

Were your prediction and explanation correct?

If not, can you explain what you observed?

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

|  |
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| **Response activity** |
| **Adding batteries (1)** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | The voltage, of batteries and power supplies, is a measure of their ‘strength’. |
| Observable learning outcome: | * Use the idea of an ‘electrical push’ to explain the effect of different battery voltages on a circuit. |
| Activity type: | Response, predict, explain, observe explain, practical/demonstration |
| Key words: | battery, current, ammeter, voltage |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic question:

* Diagnostic question: Current or voltage

**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 activity**

Students should complete this activity in pairs or small groups, and the focus should be on the discussions. It is through the discussions that students can check their understanding and rehearse their explanations.

To begin, each group should discuss the activity and use their scientific understanding, firstly to predict *what* they think will happen, and then to explain *why* they think they are going to be right. If students in any group cannot agree, you may be able to direct them with some careful questioning.

Students now carry out the practical, or watch a demonstration. You will need to decide whether it is better for each group to carry out the practical and risk some unexpected observations, or to demonstrate the activity so that everyone *observes* the same thing.

After the practical each group should be given the opportunity to change, or improve their explanation. A good way to review your students’ thinking might be through a structured class discussion. You could ask several groups for their *explanations* and put these on the whiteboard. Then ask other groups to suggest which explanation is the most accurate and the most clearly expressed, and through careful questioning work up a clear ‘class explanation’.

A useful follow up is for individual students to then write down explanations in their own words – without reference to the class explanation on the board (i.e. cover it up).

*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 a 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.

**Equipment**

For each student/pair/group:

* x2 1.5V batteries in holders
* x2 (or one) ammeters
* 2.5V bulb in holder
* x5 connecting wires

**Technician notes**

This is a situation where moving coil meters are more helpful than digital meters that report the current to four significant figures, with the last figure fluctuating, causing some students to be confused when we suggest that the current before and after the lamp is the same. If you do use digital meters it is useful to compare results from different groups to show that they do vary in the last significant figure and that we need to round up the values for comparison.

**Health and safety**

**Mains electricity:** students should be reminded that wires should never be pushed into electrical sockets. It should be made clear to them that mains supply can kill.

If there are students in your class who are at risk of ignoring this advice, then it is advisable to turn off the power to the electrical sockets in your room.

Practical work should be carried out in accordance with local health and safety requirements, guidance from manufacturers and suppliers, and guidance available from CLEAPSS.

**Expected answers**

Students with an understanding of voltage (of batteries and power supplies) as a measure of their ‘strength’ will explain the increase in current as being caused by a bigger ‘push’ from the batteries. They may suggest that doubling the batteries should double the current, which is approximately true. (Bulbs will increase in resistance as they get brighter, so the current will not quite double). The current will approximately triple with three batteries – so long as the bulb does not blow!

If students do not predict that both ammeters should read the same then this indicates that their understanding of current is not accurate. Reference to this thinking can be found in the section ‘Simple electric circuits: What is an electric current?’

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG), from EPSE E05-002

Images: UYSEG

**References**

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