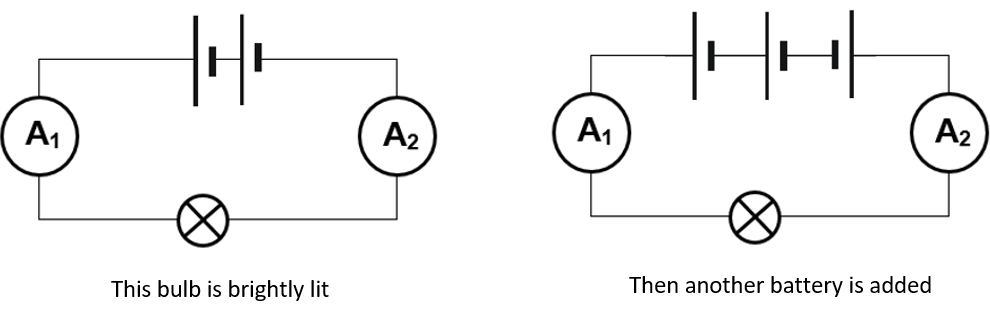
**Adding batteries (2) sheet 1**

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

**Apparatus and materials**

* X3 1.5V batteries
* x1 2.5V bulb
* x2 ammeters
* x6 connecting wires

**Predict**

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

**Explain**

Explain why you think this will happen.

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

**Observe**

Describe what happens.

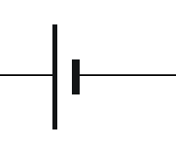
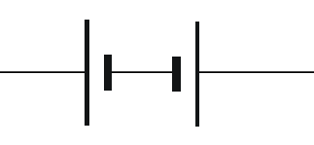
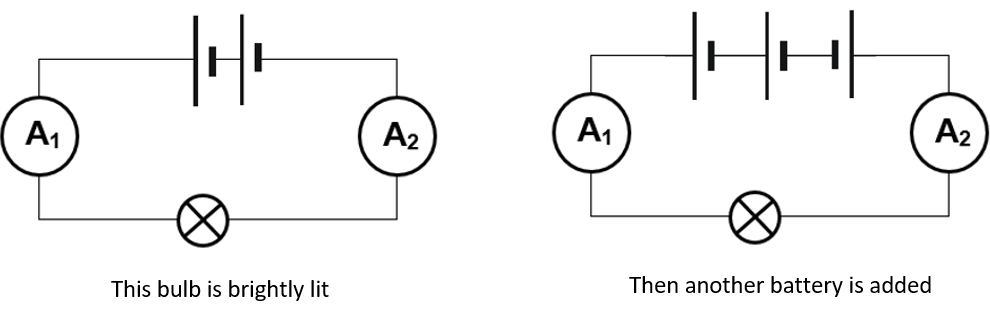
**Explain**

Were your prediction and explanation correct?

If not, can you explain what you observed?

**Adding batteries (2) sheet 2**

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



1.5V

1.5V

4.5V

This bulb is dimly lit

**Apparatus and materials**

* 1.5V battery and 4.5V battery
* x1 2.5V bulb
* x2 ammeters
* x6 connecting wires

**Predict**

What do you think will happen when the 4.5V battery is added? What do you **predict** will happen to the readings on the ammeters?

**Explain**

Explain why you think this will happen.

|  |
| --- |
| **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*

|  |
| --- |
| **Response activity** |
| **Adding batteries (2)** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | The voltage, of batteries and power supplies, is a measure of their ‘strength’. |
| Observable learning outcome: | * Apply the idea of an ‘electrical push’ to predict the effect of different series combinations of 1.5V batteries on simple circuits. * Calculate the total voltage of combinations of different batteries in series. |
| 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 questions:

* Diagnostic question: Combining 1.5V batteries
* Diagnostic question: Two different batteries

**What does the research say?**

Many students use the terms current and voltage interchangeably with electricity and with little or no understanding (Gott, 1984). This activity will develop the understanding of those students who do/do not have a clear understanding of current and 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’ – and a bigger voltage gives a bigger ‘push’. This will help students to separate out the concepts of current and voltage: current is the flow of electric charge around a circuit and the voltage of a battery is a measure of how hard the battery is pushing the current round. Driver *et al* 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:

* x3 1.5V batteries
* 4.5V battery
* x1 2.5V bulb
* x2 ammeters
* x6 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**

In the first PEOE, students with an understanding of voltage (of batteries and power supplies) as a measure of their ‘strength’ will explain the decrease in current as being caused by the extra battery ‘pushing against’ the original two batteries. They may suggest that the current should halve, which is approximately true, because the push from the extra battery will cancel out the push of one of the original ones.

In the second PEOE, the current will approximately double. The voltage of the 4.5V battery will push against the 1.5V battery to give an effective voltage of 3V.

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)

Images: UYSEG

**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.