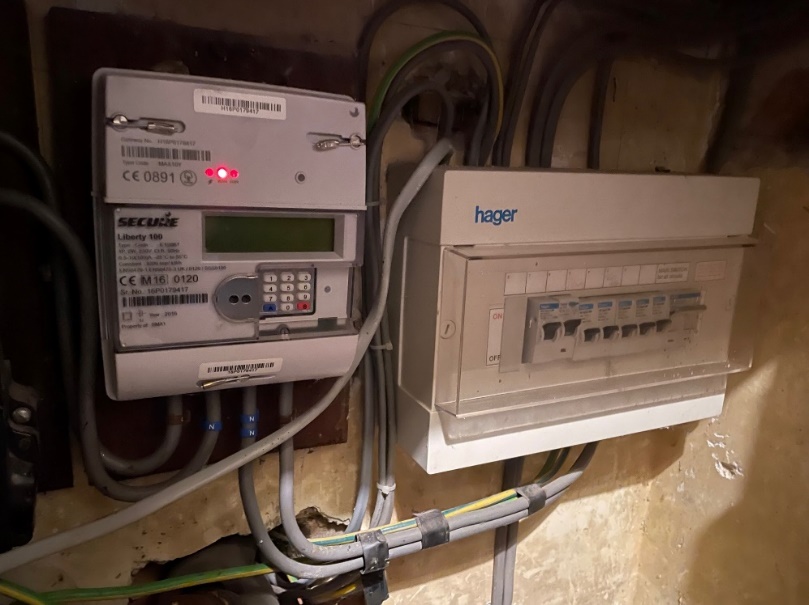
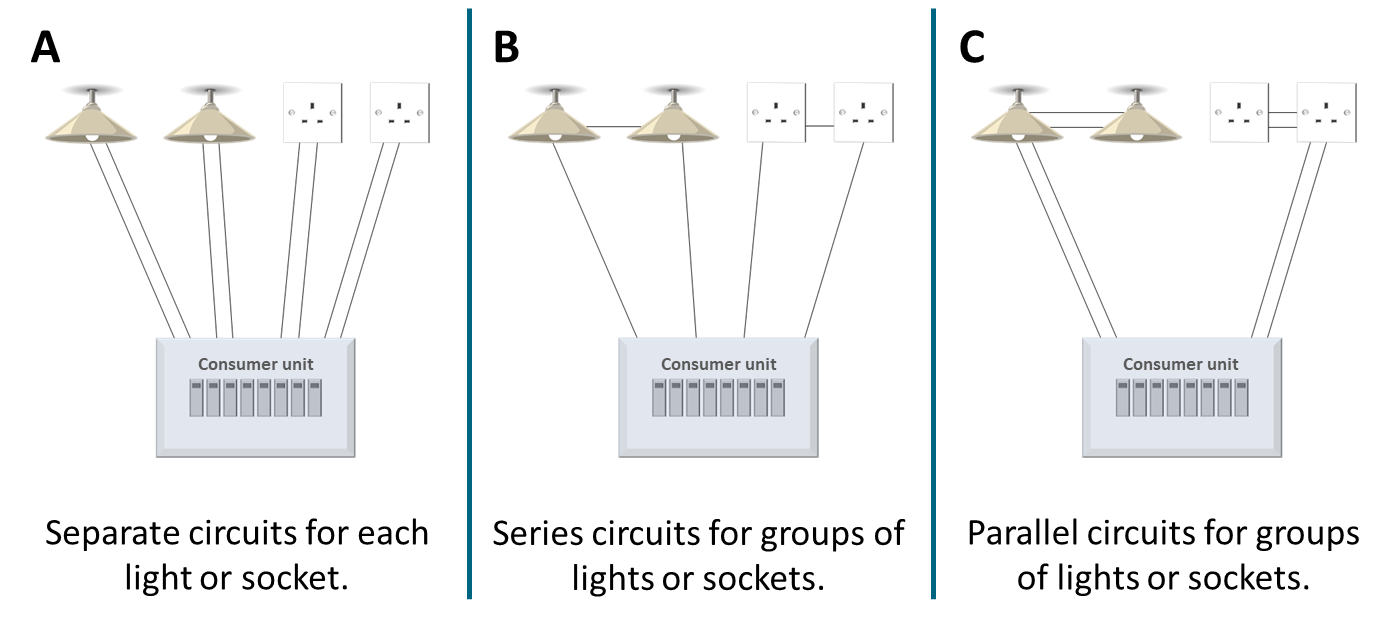
**Mains circuits**

All lights and electric sockets in a house are wired up to a consumer unit.



How are the electric circuits in a house wired up?



*Physics > Big idea PEM: Electricity and magnetism > Topic PEM8: Mains electricity > Key concept PEM8.1: Electrical safety*

|  |
| --- |
| **Diagnostic question** |
| **Mains circuits** |

**Overview**

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| --- | --- |
| Learning focus: | Fuses, circuit breakers and earth connections, used correctly, can prevent excess mains current and electric shocks. |
| Observable learning outcome: | Explain how electric circuits are wired in a home, with circuit breakers for safety. |
| Question type: | Simple multiple choice |
| Key words: | Consumer unit, fuse box, series circuit, parallel circuit |

**What does the research say?**

In thinking about mains electricity, a few students may revert to earlier misunderstandings, which are not apparent when they are dealing with series and parallel circuits, because mains electricity can appear to be very different to simple electric circuits. A common misunderstanding that children have when they first learn about mains electricity, age 7-11, is that mains appliances draw electricity from one connecting wire, without the need for a complete circuit (Pilatou and Stavridou, 2004). It is also common for young children to have the misunderstanding that each socket or light in a house is connected separately, in its own circuit, to the point at which electricity enters the house (the consumer unit).

*Additional guidance notes*

In science teaching for ages 14-16, it is rarely explained clearly why a fuse needs to be placed on the live wire and not on the neutral wire; and it is a small leap for students into misunderstanding that all of the electricity flows from the National Grid and into the house through live wires and out again through the neutral – when most of it has been used up (sic).

To support the correct explanation, the live wire can be thought of as one end of a ‘mains battery’ whose voltage (more accurately potential) varies between +230 V and -230 V. The neutral wire can be thought of as the other end of the ‘mains battery’ which has a voltage (potential) close to 0 V, which is pretty much the same as the ground (earth). A current will flow round a complete circuit made between a live wire and a neutral wire or between a live wire and the ground because there is a potential difference across it. If a complete circuit is connected between the neutral wire and the ground, there is only a very small potential difference between the connections and any current will be very small.

In other words, completing a circuit between the neutral wire and the ground can be thought of as connecting both ends of the circuit to the same end of a high voltage battery. This means that it is quite safe for a person to be connected between a neutral wire and the ground, but not between a live wire and the ground – although it should be noted that neither should be attempted (it is not completely unknown for live and neutral wires to have been connected the wrong way round).

**Ways to use this question**

Students should complete the question 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 answers to the question will show you whether students understood the concept sufficiently well to apply it correctly.

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.

*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.

**Expected answers**

C Parallel circuits for groups of lights or sockets.

**How to respond - what next?**

Groups of lights or sockets are connected in parallel circuits that each connect to one circuit breaker in the consumer unit.

A Some students may have the misunderstanding that each light or electric socket in a house is connected individually to the consumer unit (fuse box) in its own circuit.

B Others may understand, perhaps from experience, that lights or sockets stop working in groups when a circuit breaker in the consumer box switches off (trips), but do not distinguish between series and parallel circuits, with the latter necessary for lights or sockets to be turned individually on and off.

If students have misunderstandings about how electric circuits are wired in a home, it can help to provide students with an opportunity to build a parallel lighting circuit with a switch for the circuit breaker. Once set up, they could work in pairs or small groups to describe how lights can be switched on and off separately and the effect of the circuit breaker turning off (tripping).

The following BEST ‘response activity’ could be used in follow-up to this diagnostic question:

* Response activity: A working fuse

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Image: Peter Fairhurst (UYSEG).

**References**

Pilatou, V. and Stavridou, H. (2004). How primary school students understand mains electricity and its distribution. *International journal of science education,* 26(6)**,** 697-715.