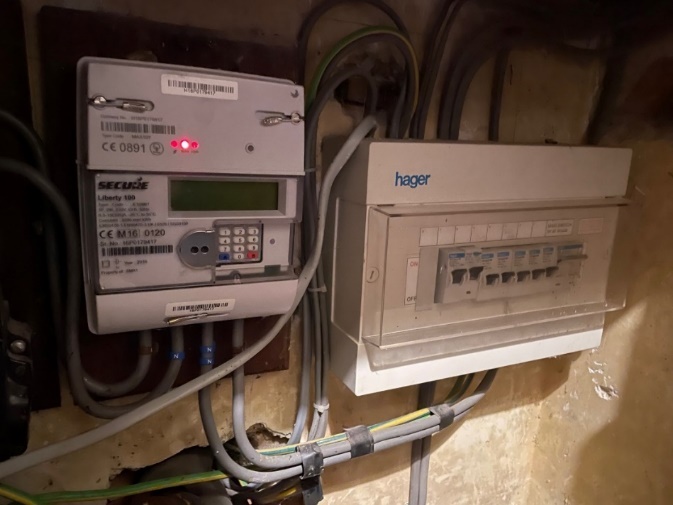
**Consumer unit**

Electricity enters a house at one point.

It passes through an electricity meter and a consumer unit.

All the electrical wiring in a house is connected to the consumer unit.



*In houses, most fuse boxes have been replaced with consumer units.*

*Consumer units use circuit breakers (or RCCBs) instead of fuses.*

A consumer unit contains circuit breakers.

If too much current flows through a circuit breaker, it turns off and stops the electrical current.

These statements are about the circuit breakers in a consumer unit.

For each statement, tick (✓) **one** column to show what you think*.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | I am **sure** this is right | I think this is right | I think this is wrong | I am **sure** this is wrong |
| **A** | Each circuit breaker turns off one light or one socket. |  |  |  |  |
| **B** | Each circuit breaker turns off several lights or sockets. |  |  |  |  |
| **C** | Each circuit breaker turns off one circuit in the house. |  |  |  |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Consumer unit** |

**Overview**

|  |  |
| --- | --- |
| 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: | Confidence grid |
| Key words: | Electricity meter, consumer unit, fuse box, circuit breaker, RCCB |

**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 confidence grid 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.

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**

Statements B and C are correct; and statement A is wrong.

**How to respond - what next?**

Each circuit breaker connects to one of several parallel circuits in a house. Sets of lights are connected together in circuits that carry quite small amounts of current. Several electric sockets are connected together in other circuits and an electric oven or immersion heater is usually on its own separate circuit. These circuits typically carry more current than lighting circuits.

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, C Students may have experienced several lights or sockets stopping working when a circuit breaker in the consumer box switches off (trips) and understand that statement B is correct – and think that statement C is wrong. These students are likely to base their answers on experience alone, without thinking through the reason why several sockets or lights turn off together. Alternatively, they may have the misunderstanding that several individual lights or sockets are each wired directly to a single circuit breaker, on separate circuits.

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).

Images: 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.