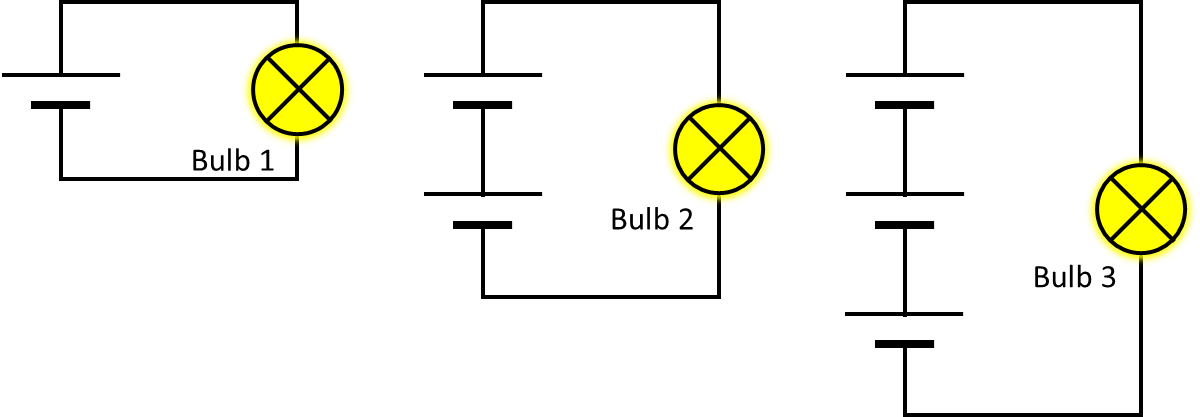
**Power and p.d.**

Each circuit contains the same type of bulb, but each one is different.

The bulbs are chosen so that the current in each circuit is the same.



***The current in each circuit is the same.***

These statements are about the three different bulbs.

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** | The brightness of each bulb is the same. |  |  |  |  |
| **B** | The p.d. across each bulb is the same. |  |  |  |  |
| **C** | The p.d. is biggest across bulb 3. |  |  |  |  |

*Physics > Big idea PEM: Electricity and magnetism > Topic PEM8: Mains electricity > Key concept PEM8.2: Paying for electricity*

|  |
| --- |
| **Diagnostic question** |
| **Power and p.d.** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | The amount of energy that an electrical appliance transfers is proportional to time; and its power is proportional to the potential difference across it *and* the current through it. |
| Observable learning outcome: | Explain why the power of a component depends on the potential difference across it. |
| Question type: | Confidence grid |
| Key words: | Power, potential difference, current |

**What does the research say?**

Novice learners typically lack a scientific understanding of how a circuit works and rely on memorising equations and procedures. They may be able to solve routine circuit calculations correctly, but often cannot predict or explain the behaviour of a circuit (Liu et al., 2022).

Some common misunderstandings that students may continue to hold, which are relevant to understanding how electrical power is proportional to current, are:

* that most students do not discriminate sufficiently between current, voltage, energy and power (Gott, 1984; Shipstone, 1985; Driver et al., 1994; Engelhardt and Beichner, 2004)
* the amount of current provided by a battery is always the same no matter what circuit it is connected to (Driver et al., 1994; Engelhardt and Beichner, 2004)
* a circuit can be analysed sequentially moving around a circuit in one direction, so changes to components ‘further around a circuit’ do not affect earlier parts of the circuit (Driver et al., 1994; Stocklmayer and Treagust, 1996; Duit and von Rhoneck, 1997)
* and a bulb or appliance gets the energy ‘it demands’ regardless of the potential difference of the source (van den Berg and Grosheide, 1997).

**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**

Statement C is right; and statements A and B are wrong.

**How to respond - what next?**

Bulb 3 will be brighter than the other bulbs because it has a greater p.d. across it and the same sized current. The power of each bulb is proportional to both p.d. and current and is equal to the rate at which the bulbs transfer energy.

The greater the p.d. across a bulb, the greater the size of force pushing charge through it and the greater the rate at which they can do work on the bulb.

N.B. In this question, bulb 3 has a greater resistance than the other bulbs. It is a common misunderstanding that a bulb with a greater resistance has more power – it may do, or it may not, depending on the circuit it is in.

A Some students are likely to assume that it is the size of the current alone that determines the brightness of a bulb. However, this question is comparing three different bulbs, all of the same type. It is the bulb that requires the biggest p.d. to push the same sized current through it that has the most power and is the brightest.

B Some students may have the misunderstanding that a bulb gets the energy ‘it demands’ regardless of the potential difference of the source and that the p.d. across the bulb is not determined by the p.d. across the battery.

Other students may recall wrongly the rule for combining the p.d. across the cells in each battery. If they have used the rule for cells in parallel instead of the one for cells in series, they will expect the p.d. across each battery to be the same.

C Students are likely to recognise that this statement is correct if they understand that adding cells in series increases the p.d. across the battery. Some students may apply this rule wrongly, or have the misunderstanding that the p.d. across the bulb is determined by the bulb rather than the battery.

If students have misunderstandings about why the power of a component depends on the potential difference across it, it can help to provide students with an opportunity to review their understanding of p.d. and current in series circuits and to compare measurements of p.d. and current to the *total* brightness of bulbs in each circuit. The BEST key concept: *PEM5.1 Analysing series circuits* includes resources that can be used to help review these concepts.

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

* Response activity: Rope power

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images by Peter Fairhurst (UYSEG).

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