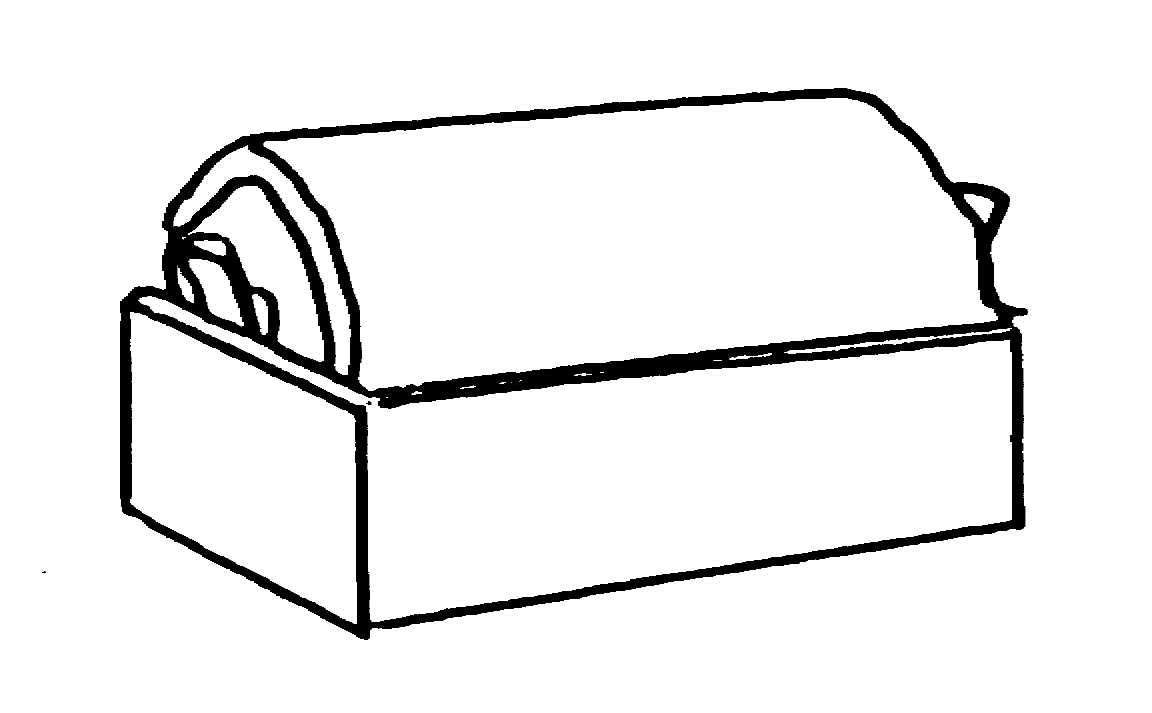
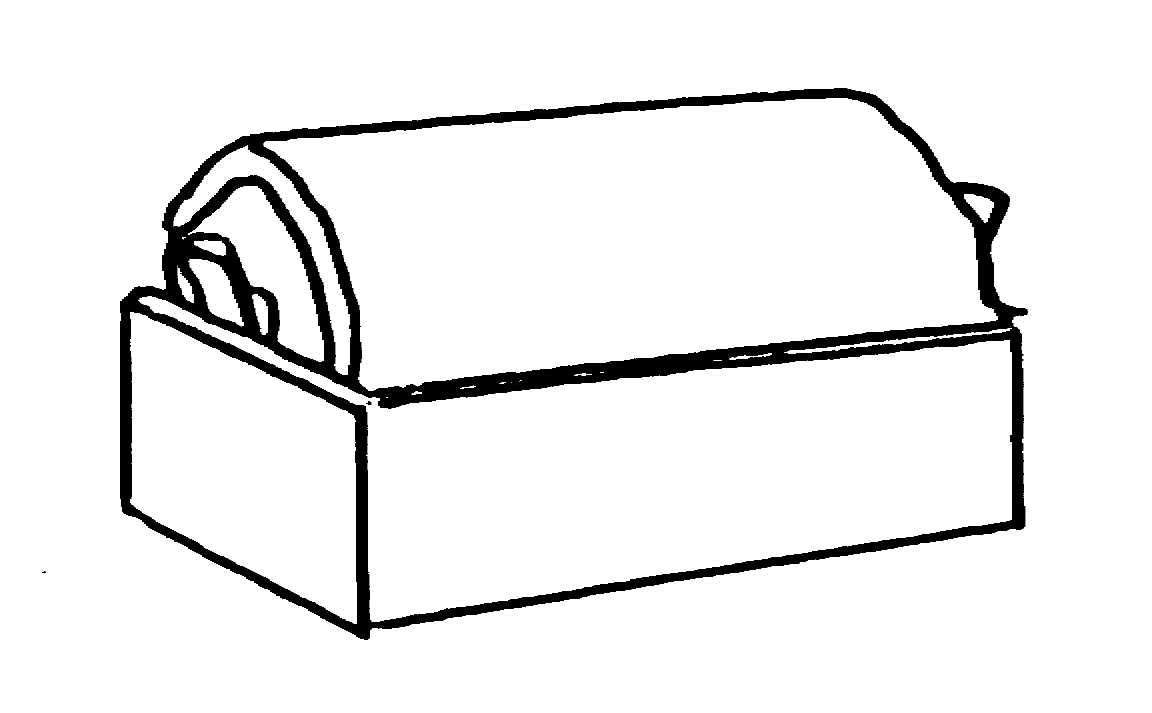
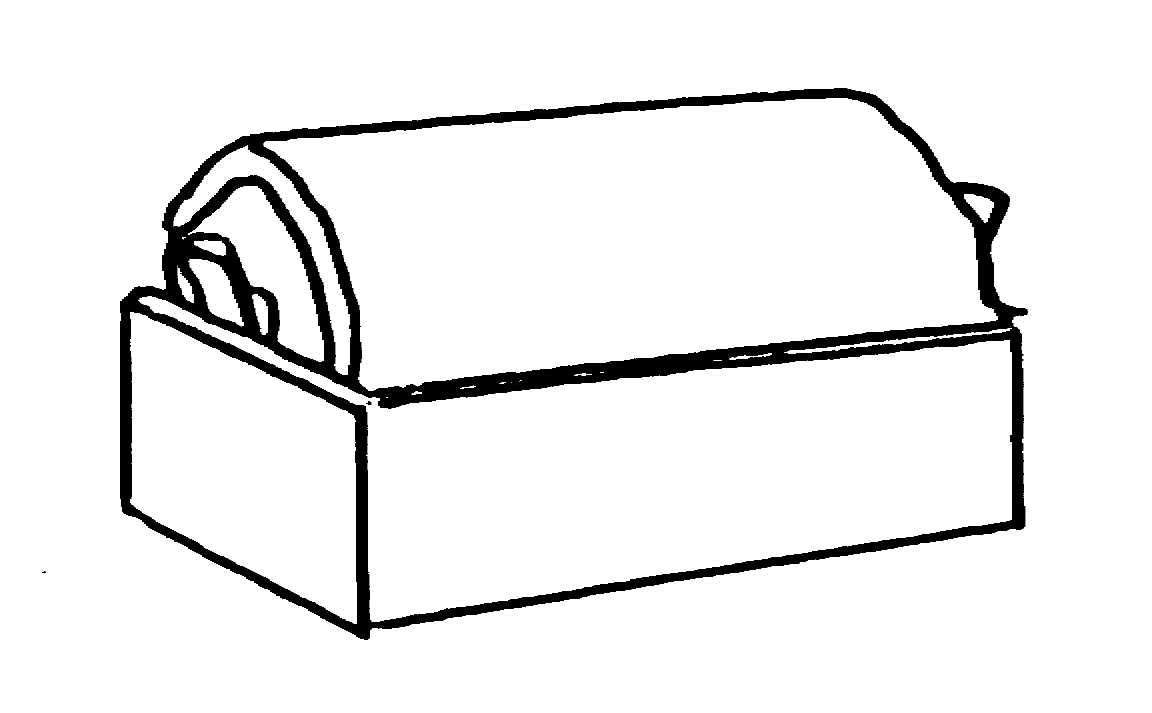
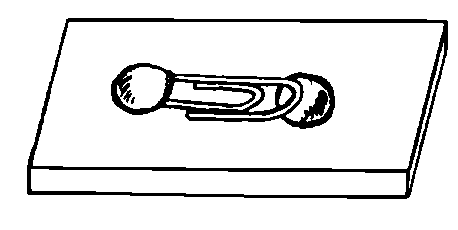
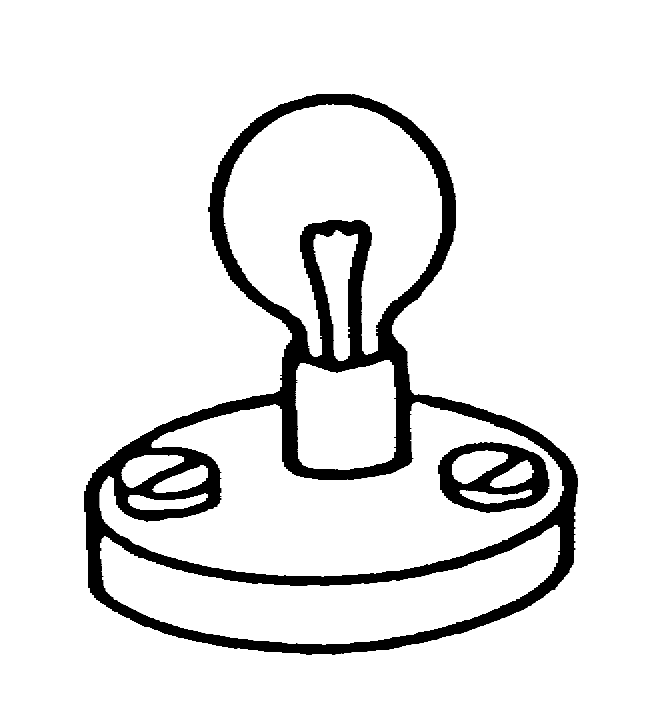
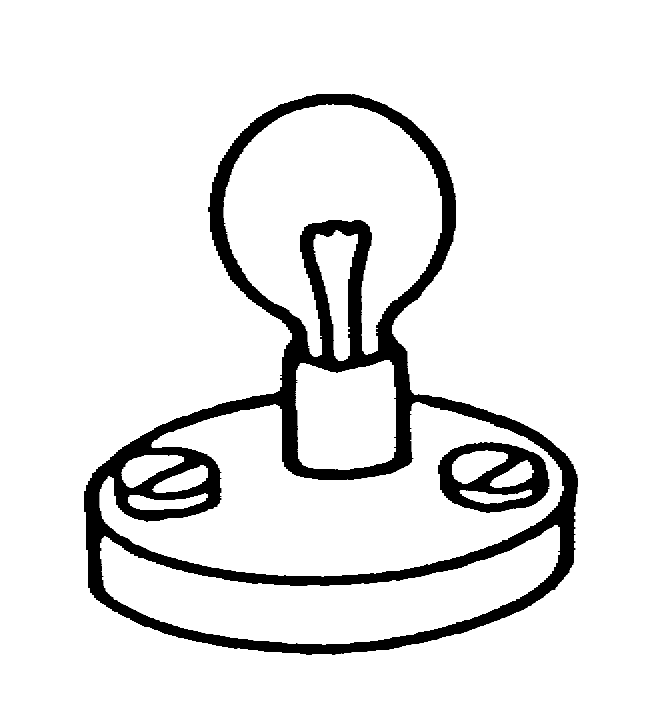
**Circuit repair**



Jacob has set up this circuit to turn on a motor and two bulbs, but it doesn’t work.

What should he do?

**Aaliyah**

You need to check all the batteries are the right way round.

**Brandon**

You need to take it all to pieces and start again.

**Harry**

Have you checked that the switch is on?

**Curtis**

I’d replace all the wires.

**Grace**

I would swap all the bulbs because they often stop working.

**Dylan**

You should connect a bulb across each battery in turn.

**Freya**

I would use a circuit with a battery and a bulb to test each component.

**Emily**

I would connect an extra wire to both ends of each part in turn.

1. Whose ideas are the most sensible ones to use? What is the best order to do them in?
2. Explain how doing these things will help to fix the circuit.
3. Whose idea would work even if more than one part was broken? Explain your answer.

|  |  |
| --- | --- |
| **Aaliyah**  You need to check all the batteries are the right way round. | **Brandon**  You need to take it all to pieces and start again. |
| **Curtis**  I’d replace all the wires. | **Dylan**  You should connect a bulb across each battery in turn. |
| **Emily**  I would connect an extra wire to both ends of each part in turn. | **Freya**  I would use a circuit with a battery and a bulb to test each component. |
| **Grace**  I would swap all the bulbs because they often stop working. | **Harry**  Have you checked that the switch is on? |

*Physics > Big idea PEM: Electricity and magnetism > Topic PEM1: Simple electric circuits > Key concept PEM1.1: Making circuits*

|  |
| --- |
| **Diagnostic question** |
| **Circuit repair** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | An electric circuit is a closed conducting loop containing a battery. |
| Observable learning outcome: | * Explain how to fault find, and fix, a more complicated series circuit without taking it apart. |
| Question type: | Diagnostic, talking heads |
| Key words: | Complete circuit, electric current, component |

**What does the research say?**

There has to be a closed loop of conducting material, from one end of the battery or power supply, through the device and back to the battery. This is a key idea about electricity that pupils have to learn, and it is important that they grasp it securely before progressing to other ideas (Shipstone, 1985).

Students generally set up circuits, and fault find, correctly if they approach the circuit in a systematic way. E.g. starting at one point in the circuit and moving from component to component in order, going clockwise or anti-clockwise from that point.

Confidence in building circuits and quickly fixing faults, will allow students to more easily construct and interpret the circuits they will use to develop their thinking on the more challenging aspects of electricity later on.

**Ways to use this question**

This task is intended for discussion in pairs or small groups. It can be done as a pencil and paper exercise or projected onto a screen.

Students should read the statements and follow the instructions on either the worksheet or the PowerPoint. Listening in to the conversations of each group will often give you insights into how your students are thinking. Each member of a group should be able to report back to the class.

Feedback from each group can be used, with careful teacher questioning, to bring out a clear description or explanation of the science.

*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 the 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.

NB in any class, small group discussions typically improve over time and a persistence with this strategy is often very successful in the medium to long term.

**Expected answers**

Aaliyah, Dylan, Emily, Freya and Harry give the most sensible strategies.

A sensible order for testing might be:

* Check the switch and that all batteries are the *same* way round.
* Connect a bulb across each battery in turn to check none of them are flat. If they are then the next tests will not work.
* Connect an extra wire to both ends of each part in turn. If the rest of the circuit starts to work then the wire has completed the circuit around a faulty component.
* It is possible to use a simple series circuit with a battery and a bulb to test each component in turn. This would take a lot longer, but may be necessary if more than one component is not working. In this case the previous checks may not find a fault.

Freya’s suggestion works if more than one component is faulty (see last bullet point).

**How to respond - what next?**

Brandon, Curtis and Grace give unsystematic answers. Ask students, who choose the actions that these talking heads suggest, how effective the suggestion will be if just one bulb (e.g.) is broken. Challenge them to describe a quicker solution.

Those not prioritising Aaliyah and Harry’s suggestions to be carried out first may be to be assuming a circuit fault is caused by something beyond their control. Challenge these students to describe how they can set up and check a circuit to avoid faults.

Dylan, Emily and Freya’s responses are best in this order. If Dylan’s suggestion of checking the batteries shows the batteries are at fault, then Emily’s test won’t give the expected results. Emily’s test creates a short circuit across a faulty component so that the rest of the circuit will then work. However shorting across a faulty battery will not affect the circuit.

Freya’s response is more time consuming and only necessary when there is more than one faulty component, which is relatively rare.

A good understanding of the reasons for testing in this order shows a thorough understanding of complete circuits and the effects of adding extra components in a circuit.

If students have misunderstandings about how to fault test, and fix, a more complicated series circuit, it may be helpful to clarify their thinking through structured discussion. One strategy is to invite a group, or a student, to explain what they would do, and then to ask the rest of the class who agrees or disagrees with their thinking. Challenge someone who disagrees to explain why they disagree, and someone who agrees to explain why they support it. Draw uncommitted students into the discussion by asking them who they agree with and why. This style of questioning encourages students to express and adapt their understanding in response to their peers. The teacher’s role is to encourage students to challenge poor ideas and to encourage a clear expression of the scientific point of view

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

* Response activity: Fixing circuits

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Image: EPSE

**References**

Shipstone, D.M. (1985). Electricity in simple circuits. In R. Driver (Ed.), Children’s ideas in science (pp. 33-51). Milton Keynes: Open University Press.