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| **Explore electrical resistance**  |
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| Testing the electrical resistivity of different materials |
| **Subject(s):** Design and Technology, Engineering, Science**Approx time:** 45-70 minutes |  | **Key words / Topics:** * resistance
* multimeter
* ohmmeter
* voltage
* current
* ohms
* probes
* resistor
* continuity
* conductivity
* tolerance
* probes
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| **Stay safe** Whether you are a scientist researching a new medicine or an engineer solving climate change, safety always comes first. An adult must always be around and supervising when doing this activity. You are responsible for: • ensuring that any equipment used for this activity is in good working condition• behaving sensibly and following any safety instructions so as not to hurt or injure yourself or others  Please note that in the absence of any negligence or other breach of duty by us, this activity is carried out at your own risk. It is important to take extra care at the stages marked with this symbol: ⚠ |
| **Suggested Learning Outcomes**  |  |  |
| * To be able to choose materials based on their resistivity
* To understand the basics of resistance
* To be able to use electronic devices to measure resistance
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| **Introduction** |  |  |
| This is one of a series of resources developed in association with the National Grid ESO, to allow learners to use the theme of electronics to develop their knowledge and skills in Design & Technology and Science. This resource focusses on practical experiments investigating the resistance of different materials. National Grid ESO ensure that Great Britain has the essential energy it needs by ensuring supply meets demand every second of every day. |
| **Purpose of this activity**In this activity learners will make use of the theme of electrical resistance to experiment with an electronic circuit. They will learn how to use an electronic multimeter and will then apply their skills to test the electrical resistivity of various materials.This activity could be used as a main lesson activity to teach about resistors and their use. It could also be used as part of a wider scheme of learning focussing on the selection of materials for different applications. |
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| **Activity** |  | **Teacher notes** |
| **Introduction (5 minutes)**Using the presentation, teacher to explain what is meant by resistance. Teacher to explain the task to learners, that they will carry out a practical investigation into resistance.**Measuring resistance (10-20 minutes)**Teacher to demonstrate how to set up and use the multimeter, including continuity testing.Learners to carry out continuity testing of a wire and a breadboard, as shown on slides 8 and 9.**Resistors (10-15 minutes)** Teacher to explain what resistors are and why they are used. Learners to investigate resistors as outlined in slides 11 and 12.**Measuring the resistance of a person (10-15 minutes)**Learners measure the resistivity of the body with dry hands, hands lightly moistened with water and hands lightly moistened with salt water. Learners to explain any differences observed.**Measuring the resistance of pencil lines (5-10 minutes)** Learners draw a thick dark pencil line on a sheet of paper, then measure the resistance with probes positioned at both ends. They then repeat this exercise with less separation between the probes.**Plenary (5 minutes)**Learners to discuss the findings: what was the variation in the measured resistor values, how did water and saltwater affect the resistance, how did the length of the conductive path affect the resistance? |  | This activity could be carried out in pairs or small groups.**Introduction**Resistance indicates how readily current will flow in a circuit. Current increases when resistance decreases, and it decreases when resistance increases. **Measuring resistance**Particular attention should be drawn to selecting an appropriate resistance range on the multimeter.Continuity testing checks that there are no breaks in the pathway for the flow of electricity.Learners could produce a sketch the possible conductive paths on the breadboard.**Resistors**This activity could be extended to look at the meanings of the colour bands on different resistors.If touching the probes, the value measured will be a parallel combination of the thing being touched and the body of the person touching the probes.The actual values of the resistor will vary within their tolerance – this is the range of acceptable values produced during manufacturing. The orientation of the resistor does not affect the current that can flow through it, so it is not possible to put it the ‘wrong way round’ in a circuit. No result is obtained if only one probe is touched against the resistor, as it is ‘open circuit’.**Measuring the resistance of a person**Salt water should be prepared in advance using a glass of water and table salt.**Measuring the resistance of pencil lines**The pencil should be a graphite type.If the results are inconsistent, the mark may need to be redrawn with more and heavier pencil strokes so that it is consistent in its density. Learners should establish that reducing the separation of the probes reduced the resistance. |
| **Differentiation** |  |  |
| **Basic** |  | **Extension** |
| * Set up the multimeter in advance to the correct range before handing to learners.
 |  | * Produce a sketch showing which holes on the breadboard are connected to each other.
* Investigate the resistance of other materials. Which materials are most/least conductive?
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| **Resources** |  | **Required files** icon-docicon-pdficon-ppt |
| * Multimeters (digital or analogue)
* Assorted resistors, including 33kΩ
* Breadboards
* Crocodile clips
* Pencils and paper
* Glass of water
* Table salt
* Selection of materials (for the extension activity)
 |  |  Presentation - Exploring electrical resistance |
| **Additional websites** |  |  |
| * **National Grid website:** Homepage for the National Grid with lots of information about the network. <https://www.nationalgrid.co.uk/>
* **What is electrical resistivity:** <https://www.youtube.com/watch?v=FFHUoWFtab0>
* **What are resistors:** <https://www.youtube.com/watch?v=utDPJZA7118>
* **Using Ohms law**: <https://www.youtube.com/watch?v=uZ-m91IEkjQ>
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| **Related activities (to build a full lesson)** |  |  |
| **Starters** (Options) * Get learners to walk through a double door as a group – then try again with one door closed, and discuss what has happened
 | **Plenary*** Discuss the findings: what was the variation in the measured resistor values, how did water and saltwater affect the resistance, how did the length of the conductive path affect the resistance?

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| **The Engineering Context**  |
| * Many components, such as integrated circuits, can be damaged by high current. An understanding of resistance allows electrical engineers to select resistors to protect these components, ensuring the effective and continued operation of the electronic devices.
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| **Curriculum links** |
| **England: National Curriculum**Science KS3* The differences in resistance between conducting and insulating components
 | **Northern Ireland Curriculum**Technology & Design* use investigative skills to explore scientific issues, solve problems and make informed decisions
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| **Scotland: Curriculum for Excellence**Technologies* Through investigation, I understand the relationship between current, voltage and resistance. I can apply this knowledge to solve practical problems. SCN 4-09a
 | **Wales: National Curriculum** Design and Technology* the uses of electricity and its control in simple circuits
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| **Assessment opportunities** |
| * Informal teacher assessment of practical skills through observation of learners.
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