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| **Ohms law resistor calculation with BBC Micro:bit** |
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| Understand the relationship between voltage, current and resistance |
| **Subjects:** Design & Technology, Science**Approx. time:** 15 minutes |  | **Key words / Topics*** BBC micro:bit
* light emitting diode (LED)
* anode**,** cathode
* resistor
* ohm’s law
* voltage, current, resistance
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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: ⚠  |
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| **Suggested Learning Outcomes**  |  |  |
| * To calculate the value of a protective resistor for an LED.
* To use and apply Ohm’s Law.
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| **Introduction** |  |  |
| This is one of a series of resources to support the use of the BBC micro:bit in Design and Technology lessons. People are always looking for ways to save energy. It is estimated that the average UK homeowner could save up to £240 a year alone on the cost of lighting their home.In this unit of learning, learners will use the BBC micro:bit to develop a prototype for an LED based automatic home lighting system, designed to save energy.  |
| **Purpose of this activity**In this activity, learners will understand the importance of and use Ohm’s law to calculate the value of a protective resistor for an LED.This could be used as an extension activity with ‘Design an automatic lighting system’ as the main lesson activity. It could also be used in a more general electronic theory lesson or when understanding the relationship between voltage, current and resistance. |

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| **Activity**  |  | **Teacher notes** |
| **1. Unit theme**Introduce the theme of the unit. Learners are going to use the BBC micro:bit to produce a prototype lighting system that saves energy in the home. Introduce the idea of using light emitting diodes (LEDs) instead of incandescent bulbs.**2. Light emitting diodes**Briefly overview the main points about what LEDs are and how they work using the teacher PowerPoint as a guide. These should include:* Output device
* Usually needs a protective resistor
* Produces light when current flows from the anode to the cathode lead
* Uses much less energy than an incandescent bulb
* Ideal for home lighting

Explain what is meant by a protective resistor for an LED and why it is needed. What would happen to the LED if it was not protected in this way?**3. Using Ohm’s law**Introduce Ohm’s law and the relationship between voltage, current and resistance. Use the formula triangle for V = IR to show how each depends on the others and how the formula can be rearranged.Ask learners to calculate the value of the resistor that they would need to protect an LED if the power supply is 5V, the LED uses 2V and the LED draws a current of 20mA (0.02A).Once learners have attempted the calculation, show the answer on the board and how it has been achieved. Learners could also peer assess each other’s responses. |  | The IET TV video – Saving Lighting Energy <https://tv.theiet.org/Index.html?videoid=7299> can be shown as an introduction or starter for activities in this unit of work.When introducing new components, such as LEDs and resistors, it is useful to have real examples of them to hand out for learners to handle. It is also useful to show a working LED so learners unfamiliar with them can see what they do and how they work.**Ohm’s law**When introducing Ohm’s law for the first time it would be useful to explain the differences between voltage, current and resistance. For example, in simple terms, current is the flow of electricity, voltage is the push that makes the electrons flow round the circuit and resistance slows this flow down.The formula triangle can be used to help learners rearrange the formula to calculate what they need to. If calculating resistance learners should cover the R in the triangle, and what remains is the formula. So, R = V/I Learners may use calculators in this activity.**Task answer:**5V – 2V = 3VV = I x R so R = V/IR = 3/0.02 = 150 ohms |
| **Differentiation** |  |  |
| **Basic** |  | **Extension** |
| Some learners may require examples of using Ohm’s law to be shown to them before attempting the main calculation. If the school or class has ‘Numeracy Champions’ or similar these could be used to help and support those learners with weaker numeracy skills.Lower ability classes could attempt this as a whole class activity with the teacher taking them through each stage of the working out. |  | Attempt additional calculations to work out voltages and currents using Ohm’s law. Set up a circuit on a breadboard with an LED and a resistor to demonstrate the effect of removing the protective resistor on the LED. If not wanting to damage actual components this could be done virtually using circuit simulation software. |
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| **Resources** |  | **Required files icon-docicon-pdficon-ppt** |
| * Projector/Whiteboard
* Exercise books or folders
* Calculators
 |  | icon-ppt Calculating Protective Resistor Values for LEDs presentation |
| **Additional websites** |  |  |
| The following websites can be used for providing additional technical information and supporting delivery to learners.* **IET TV – Saving Lighting Energy:** Supporting IET TV video - ideal for use as part of a starter or introductory activity to support this resource. <https://tv.theiet.org/Index.html?videoid=7299>
* **Bitesize – Ohm’s Law:** Video explaining Ohm’s Law. <https://www.bbc.co.uk/bitesize/guides/z8b2pv4/video>
* **Wikipedia – Resistors:** Technical information about resistors and their use. <https://en.wikipedia.org/wiki/Resistor>
* **YouTube – What is Ohm’s Law?:** Video describing Ohm’s Law. <https://www.youtube.com/watch?v=_xF1RJFEP4w>
* **Study.com – Ohm’s Law Video:** Video showing the relationship between voltage, current and resistance. <http://study.com/academy/lesson/ohms-law-definition-relationship-between-voltage-current-resistance.html>
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| **Related activities (to build a full lesson)** |  |  |
| **Starters*** ACTIVITY: What am I? Inputs and outputs
* IET TV VIDEO – Saving Lighting Energy <https://tv.theiet.org/Index.html?videoid=7299>

**Main*** ACTIVITY: Design an automatic lighting system
 | **Plenary*** ACTIVITY: Resistor calculation
* Opportunities within activity for presentations, peer/self assessment
* Reflection on Objectives and PLTS skills used
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| **The Engineering Context** film |
| Sustainable lighting is an ideal topic for teaching about programmable components and embedded intelligence in products. These are key parts of the 2014 programme of study for Design and Technology at key stage 3. It is also an ideal vehicle for using the BBC micro:bit in the classroom and developing the programming skills of learners. |

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| **Curriculum links**  |
| **England: National Curriculum**Design & Technology * KS3 4c, 4d

Science, Physics* potential difference, measured in volts, battery and bulb ratings; resistance, measured in ohms, as the ratio of potential difference (p.d.) to current
 | **Northern Ireland: Curriculum**Technology & Design* KS3 Knowledge and Skills: Control – incorporate control systems, such as mechanical, electronic or computer-based, in products and understand how these can be employed to achieve desired effects.

Learning Outcomes:* show deeper understanding by thinking critically and flexibly, solving problems and making informed decisions, using Mathematics and ICT where appropriate.
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| **Scotland: Curriculum for Excellence**Technologies* TCH 3-01a, TCH 3-13a
 | **Wales: National Curriculum**Design and Technology* KS3 Skills: Systems and Controls 16, 18
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| **GCSE D&T**AQA D&T* 3.1.4

Edexcel D&T* 1.6.3c, 5.2.3b, 5.5.2a, b, c, d

Eduqas D&T* 2.1 Core: 5
* 2.1 Systems: 1

OCR D&T* 6.4b i
 | **GCSE Engineering**AQA Engineering* 3.3.3, 3.4.1
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| **GCSE Science**AQA Combined Science Trilogy* 6.2.1.3

AQA Combined Science: Synergy* 4.7.2.2

Edexcel Combined Science* Physics: 10.13, 10.15

Eduqas Combined Science* 2.3: 7.1c/d

OCR Gateway Science: Combined Science A* P3.2c/d

OCR 21st Century Science: Combined Science B* P3.1: 3, 4
 | **GCSE Physics**AQA Physics* 4.2.1.3

Edexcel Physics* 10.13, 10.15

Eduqas Physics* 7.1c/d

OCR Gateway Science: Physics A* P3.2c/d

OCR 21st Century Science: Physics B* P3.2: 3, 4
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| **Assessment opportunities** |
| Assess the written responses of learners. Could mark in the style of an examination question, awarding marks for working out, correct answer and units. Opportunity for learners to peer assess each other’s responses to the main calculation task. |
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| **Personal, learning & thinking skills (PLTS)** |
| * Independent enquirer
* Self manager
* Effective participator
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