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| **Make a water mill that generates electricity** | | | |
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| Making a water mill to produce electricity and power an LED | | | |
| **Subject(s):** Design and Technology, Engineering  **Approx time:** 40-60 minutes |  | | **Key words / Topics:**   * electrical power * generators/motors * hydroelectricity * light emitting diodes (LEDs) * renewable energy * water mill * wires |
| **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 understand what is meant by, and the need for, renewable energy. * To be able to make and test a water mill that produces enough electricity to light an LED. * To understand how water wheels work. | | | |
| **Introduction** |  | |  |
| This is one of a series of resources designed to allow learners to use the theme of the achievements of the Ancient Greeks to develop their knowledge and skills in Design and Technology and Engineering. This resource focusses on making and testing a water wheel that generates electricity.  The ancient Greeks used water mills to grind grain. These days we can use the power of the water to make clean, green electricity! Your challenge is to make a water wheel that creates enough electricity to make an LED light up when it turns. | | | |
| **Purpose of this activity**  In this activity learners will use the achievements of the ancient Greeks to make a water mill that can produce enough electricity to light up an LED.  This activity could be used as a main lesson activity to teach about renewable energy and how electricity can be generated using the power of moving water. It could also be used as part of a wider scheme of learning to support focussed practical skills within Design and Technology and Engineering, or about the history of Engineering achievements across the world. | | | |
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| **Activity** |  | | **Teacher notes** |
| **Introduction and safety (5-10 minutes)**  Teacher to explain the task to learners and hand out tools, equipment and resources required. Teacher to explain potential safety issues when using tools and equipment.  **Making the water mill (30-40 minutes)**  Teacher to demonstrate steps shown below and on the presentation. Learners to then follow these steps to make their own water mill.   * Step 1 – Push both legs of the LED into one end of the block connector. Connect a red wire to the long leg of the LED and a black wire to the short leg of the LED through the other end of the block connector. ⚠ * Step 2 - Connect the black wire to the negative leg of the generator. Connect the red wire to the positive leg of the generator. ⚠ * Step 3 - Attach the water wheel blades to the generator. Make sure these are secured firmly in place. * Step 4 - Turn the plastic container upside down to create the base. Attach the motor clip to the base. * Step 5 - Fit the motor to the clip with the water wheel facing outwards from the base.   **Testing the water mill (5-10 minutes)** ⚠  Learners to use a tap or other source of running water to test the water mill. The LED should light up as the wheel turns. |  | | **Resources**  The motor/generator used is a 5.5V motor capable of producing up to 100mA of current. It has a rated speed of 100 – 6000rpm. If using a motor that requires more rpm to generate electricity then a gearbox or pulley system may be required to increase the speed of rotation from the wheel. Water wheel blades could be pre-produced in advance, for example, using a 3D printer or by cutting quarters from a polymer pipe and attaching to a solid cylinder with an interference-fit hole to push onto the generator, or kits can be purchased online from suppliers such as Amazon or Rapid Electronics. The LED should light up when the blades rotate. As an alternative, a water wheel made using craft sticks is shown in the links section.  **Making**  Step 1 - Instead of a block connector, the wires could be soldered to the LED legs if soldering equipment is available. Wires should be cut to an appropriate size either by the learners, or by teachers in advance. Many modern hi-bright LEDs do not require a protective resistor, but some do. This must be checked before assembling the prototype.  Step 2 - Wires can be soldered to the legs of the generator or wrapped around the legs, with insulation tape used to secure them. Always be careful working with electrical wires.  Step 3 - Blades could be pre-produced in advance by the teacher (for example, using laser cutter or 3D printer), or kits can be purchased from Amazon or Rapid Electronics. The LED should light up when the blades rotate.  Step 4 - Any water resistant adhesive suitable for joining plastics will work for this, for example super glue or a glue gun. Take care when using adhesives not to inhale or spill. |
| **Differentiation** |  | |  |
| **Basic** |  | | **Extension** |
| * Pre-produce the blade assembly for the generator. * Pre-cut wires to size and provide a wiring diagram, circuit diagram and/or exemplar product to aid understanding of the assembly requirements. |  | | * Make a water tank for the water mill and a stand for it to sit on. * Improve the design of the circuit by adding a power switch. |
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| **Resources** |  | | **Required files** icon-docicon-pdficon-ppt |
| * Hi-bright light emitting diodes (LEDs). * Block connectors with two pin connections at either end, or solder and soldering equipment. * Insulation tape. * Red and black wires or crocodile clips. * DC generator/motor (a motor working in reverse acts as a generator). * Pre-made or purchased turbine blades to attach to the generator. * Motor clip/holder. * Plastic container. * Sticky/adhesive pad. * Source of moving water (tap) |  | | Make a water mill that generates electricity presentation |
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| **Additional websites** |  | |  |
| * **YouTube – How to make a water mill:** Instructions on how to make a water mail using household objects: <https://www.youtube.com/watch?v=a2MnqXxgeTg> * **LUTW website:** Official website of the Light up the World Foundation, a charity that provides lighting solutions to people with no access to mains electricity: <https://lutw.org/> * **BBC Bitesize – Renewable energy:** Video and revision notes explaining sustainability and the uses, advantages and disadvantages of different renewable energy sources: <https://www.bbc.co.uk/bitesize/guides/zf8ck2p/revision/3> * **Association for Renewable Energy website:** Website for a not-for-profit organisation that champions the development and use of renewable energy solutions. <https://www.r-e-a.net/> | | | |
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| **Related activities (to build a full lesson)** |  | |  |
| **Starters** (Options)   * Research the engineering achievements of the Ancient Greeks. * Discuss the benefits and limitations of different types of renewable energy sources such as hydro, solar and wind. | | **Extension** (Options)   * Make a water tank for the water mill and a stand for it to sit on. * Improve the design of the circuit by adding a power switch.   **Plenary**   * Discuss results of testing/evaluate the finished product. * Self/peer assessment of completed prototypes. * Discuss the applications of waterpower and how this could be used to replace fossil fuels in the future. | |
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| **The engineering context** film |
| * Engineers have a social and moral responsibility to consider the effects of the environment when solving design problems. * The renewable energy sector is one of the biggest growing industries within engineering, so an understanding of ways to produce greener energy is essential for anyone looking to become an electrical or electronic engineer. |

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| **Curriculum links** | |
| **England: National Curriculum**  Design and technology   * KS2 1b. * KS2 2a, 2b. * KS2 4b, 4c. | **Northern Ireland Curriculum**  Personal development and mutual understanding   * Mutual understanding in the local and wider community, valuing and celebrating cultural difference and diversity, playing an active and meaningful part in the life of the community and being concerned about the wider environment.   The world around us   * Movement and energy: the causes and effect of energy, forces and movement. |
| **Scotland: Curriculum for Excellence**  Technological developments in society and business   * TCH 2-05a. * TCH 2-06s. * TCH 2-07a.   Craft, design, engineering and graphics   * TCH 2-09a. * TCH 2-12a. | **Wales: National Curriculum**  Design and Technology   * KS2 Skills: Designing 1, 5. * KS2 Skills: Making 1, 2, 3, 4. |
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| **Assessment opportunities** | | |
| * Formal teacher assessment of completed water mills and practical skills used. * Peer and/or self-assessment of completed water mills. | | |
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