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| **Build your own Christmas lights** | | |
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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: ⚠ | | |
| **Age range: 7 – 13 years**  **Approx time: 1 hour** |  | **Key words / Topics:**   * Electrical Circuit * Series and Parallel * Amperes, voltage, resistance, current |
| **Equipment** ⚠ |  |  |
| * A 2 x AA battery pack and batteries * A 3V solar panel * At least eight crocodile leads * At least 4 LEDs (Different colours if possible) * 2.5V bulb to show the difference in light emitted |  |  |
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| **The Challenge** |  |  |
| Many of us love to decorate our homes with lights at Christmas but this can be a problem for our environment.  Using non-renewable sources of energy means we are contributing to the problem of global warming and making the ice cap melt around the two poles.  Poor Santa is beginning to worry. It may not be long before he has to move away from the North Pole or develop a new workshop and home underwater. We can help him. We are going to investigate different types of circuit and electrical components to find out which would have the least impact on the environment. | | |
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| **Series versus parallel circuits** |  |  |
| **Step 1**    Make a circuit with one LED in it by connecting the battery pack to the LED using crocodile leads.  LEDs will only work if you connect them the right way around, so make sure you have the long leg of the LED on the same side as the positive (red wire) terminal of the battery pack. Like on the image below:  This is called a **series** circuit. Look at how bright the LED is. Try replacing the LED with a 2.5V bulb. How bright is the bulb?  Try connecting another LED into the same circuit. How bright are the two LEDs now (if they light up at all)?  Now we are going to put the two LEDs into a **parallel** circuit.  Make up your circuit as you did before, but this time don’t put the two LEDs in *series* in the circuit. Clip one of your crocodile leads onto the crocodile clip of the first LED and the other lead onto the other crocodile clip.  Check your second LED is the right way around (longer leg on the positive side).  How bright are your LEDs now?  Add another LED in the same way. **Are they as bright with three in the circuit?**  If you have more LEDs and crocodile leads, keep adding more LEDs in parallel until they no longer light up. | | |
| **Battery versus solar energy** |  |  |
| Now replace your battery pack with the solar panel and do the same thing as before. Make a circuit with one LED and then add LEDs in a series circuit before trying to add them in parallel.  You will need to make sure you can either take your circuit outside or be near a window in daylight.  Are the LEDs as bright as with the battery pack? How does the weather affect the brightness of the LEDs? Can you add as many LEDs to your parallel circuit as you could with the battery pack? | | |
| **The science** |  |  |
| **Resistance**  All electrical components offer some **resistance** to the flow of electricity, even really good conductors such as copper wire. If we put too much resistance in a circuit by adding more wires and LEDs, buzzers or motors, the flow of electricity slows down or even stops.  **Current**  In the first series circuit, with just one LED, there is only a small amount of resistance, so the LED is bright. If we try to add another LED in series, the two LEDs will be very dim or may not even light up at all. This doesn’t necessarily mean there is no flow of electricity, it just means it is too slow to heat up the diode in the LED to make it glow. We call this flow of electricity the **current**.  **Voltage**  We could add another battery pack to provide more **voltage**. This is the pressure available to push the electrical flow around a circuit. The trouble with this, is that it has an impact on the environment.  A series circuit is also not very useful in lighting. If one LED fails, then none of them will light up as the break in the diode creates a break in the circuit. Imagine your house if a table lamp bulb stopped working and then all the lighting in your house went out as well!  **Parallel circuit**  A much better option is to connect the LEDs using a parallel circuit. This means that each LED is on its own pathway and the electricity has only one lot of resistance from the LED on each route. Each LED gets an equal share of the current. We can measure this in **amperes**. There is a video link below to explain this further.  In theory, the LEDs will all be equally bright, but you often find they are slightly different. This could be that the different colour LEDs have slightly different resistance, or it could even be that one make of LED or even one particular batch has been manufactured differently and this is altering the resistance. That’s science though, it’s not always as exact as we might like to think it is!  Another big advantage of a parallel circuit is that if one LED fails, the others continue to work. That is why we use this type of circuit in our houses.  **Solar energy**  We can replace our non-rechargeable batteries with solar power, or another **renewable energy** source, which would be much better for our environment. In this activity we are using solar panels which transfer solar energy into electrical energy and then into light energy without storing it. This wouldn’t be very useful because it would mean our Christmas lights would only work during the day if the solar panel was in direct sunlight.  In order to use them at night we would need to add in a storage cell, such as a **rechargeable battery**, which could store the energy until we turn on the lights in the evening. We would still need to make sure that the solar panel is in direct sunlight during the day, though, to make sure our lights came on every evening.  You might wonder why we continue to use electricity (mains or battery powered) for our Christmas lights rather than making use of solar energy or even just rechargeable batteries. The problem is that non-rechargeable batteries are much cheaper and hold their initial charge for longer than rechargeable batteries. Sometimes on low drain products, it is much more economical to use non-rechargeable batteries. These are items which do not draw a large amount of electric current and are used intermittently such hair trimmers, electric toothbrushes, heating thermostats and LED lamps.  We have also become used to cheap products which we just throw away after Christmas and then buy new ones the following year, so rechargeable batteries are not used in these. Think about what you could do with your toys and decorations to help the environment rather than throwing them away.  Next time you buy your Christmas lights, think about what you could do differently to help protect our environment, particularly Santa’s North Pole! | | |
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| **The Engineering Context** film |
| You can see how this works in this video <https://www.bbc.co.uk/bitesize/clips/zrg6sbk>. |

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| **Curriculum links** | | |
| **England: National Curriculum**  Design and Technology   * KS2: 1b, 2a, 2b, 4c   Science  KS2 Electricity:   * construct a simple series electrical circuit, identifying and naming its basic parts, including cells, wires, bulbs, switches and buzzers * identify whether or not a lamp will light in a simple series circuit, based on whether or not the lamp is part of a complete loop with a battery * recognise that a switch opens and closes a circuit * use recognised symbols when representing a simple circuit in a diagram |  | **Northern Ireland Curriculum**  Science and Technology   * Movement and energy: The causes and effect of energy, forces and movement |

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| **Scotland: Curriculum for Excellence**  Technologies   * TCH 2-09a, TCH 2-11a, TCH 2-12a   Sciences  SCN 2-09a |  | **Wales: National Curriculum**  Design and Technology   * KS2 Designing: 5 * KS2 Making: 2, 3, 4 * KS2 Systems and control: 14   Science:   * KS2 How things work: 1 |