LED Lamp

The Brief

To make a functioning LED lamp

The Specification

Must light up using 8 LEDs

Must be made with thermoplastic

Must be cut by a laser cutter

Contents

#1 How to make a LED Lamp

To design projects on the computer To learn how to wire	To solder correctly

Skills

Resistors Switches Batteries	LEDs Simple Circuits

Electrical Components

Soldering Iron Laser Cutter	Line Bender

Tools

Thermoset plastic Thermoplastic	Solder

Materials

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#2 Skills

#2.1 Computer designing

#2.2 Wiring

#2.3 Soldering

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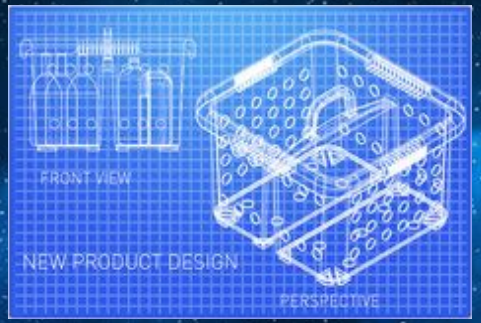
#2.1 Computer Designing



When designing a model, you will need to convert your initial design sketches to CAD. This is a program that helps you draw models in 2D or 3D on a computer. You can then transfer your CAD model to CAM which allows you to print your design in 3D or to laser cut it.

CAD: is the abbreviation for Computer Aided Design. It is a program which allows you to edit, test, modify and create a digital design.

CAM: is the abbreviation for Computer Aided Manufacture. CAM uses the data from CAD software to create and machine your finished design.

TOP TIPS

Top Tips

- If your design has a line of symmetry, you can copy and flip one half of it to ensure that your finished work is perfectly symmetrical.

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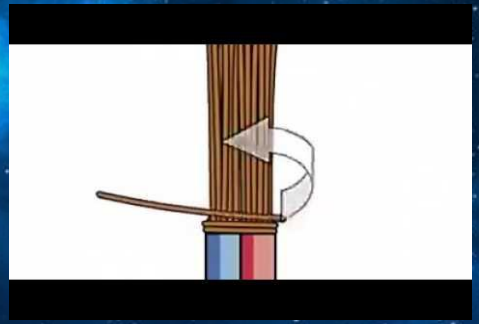
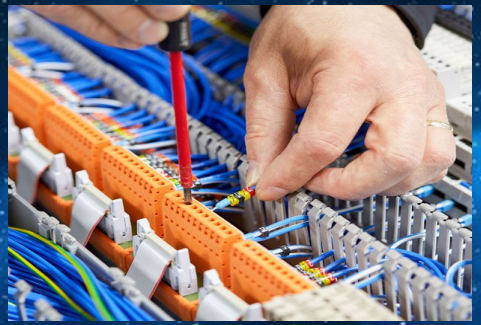
#2.2 Wiring





There are 5 main types of wire:

Triplex Wires: a wire consisting of three individual strands of copper each insulated and coiled together
Main Feeder Wire: they are made with stranded or solid wire covered in Thermoplastic High Heat-resistant Nylon coated or THHN
Panel Feed Wires: these are generally black insulated THHN wires that connect to a junction box which then sends power to lights and other electrical objects around the house.
Non-Metallic Sheathed Wires: they have 2 - 3 resistors and each individual coil of wire inside is insulated.
Single Strand Wires: they have one long piece of metal running through them and are also THHN wires.

Top Tips

- When soldering, hold the wire by the insulated rubber as the metal strands may become hot.
- When connecting two wires together, twist the metal ends together first. This will make soldering them together easier as you will only need a small amount of solder to connect the wires.

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#2.3 Soldering

Soldering irons are used for connecting two pieces of metal together. This is done by melting solder to form a joint between the two pieces of metal. Soldering is the normal method of joining together electrical components in a circuit.

Soldering irons are extremely hot and reach an average temperature of around 450 degrees celsius.

When soldering you should hold your hands at 45 degree angles, one hand holding the solder, and the other holding the soldering iron. You should move both of your hands in at the same time to the point where you need to connect your metals. When the soldering iron and the solder meet together, the solder will melt, and once cool, harden to form a strong connection.

TOP TIPS

Top Tips

- Always wait for the soldering iron to heat up to its maximum temperature or the solder might not liquify and you will not get a strong connection between your two pieces of metal.
- Don't put too much solder on, or it will just form messy clumps.

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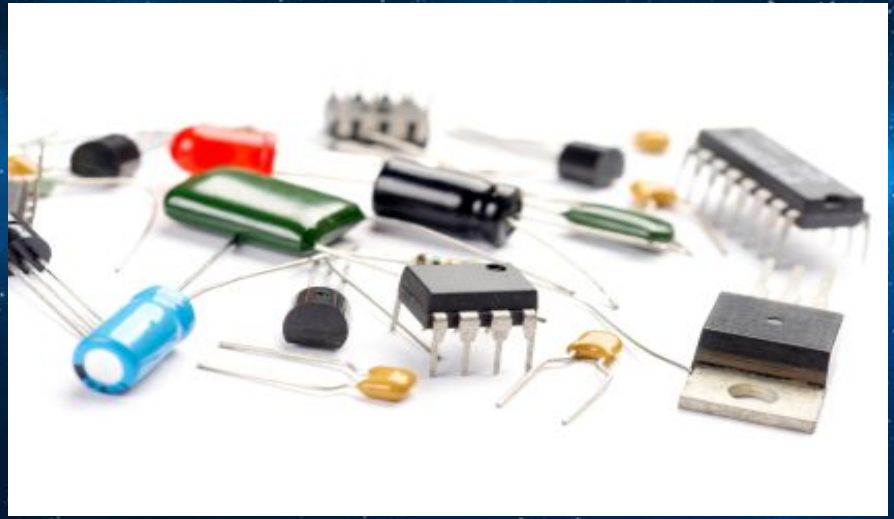
#3 Electrical Components



- #3.1 Resistors
- #3.2 Switches
- #3.3 Batteries
- #3.4 LEDs
- #3.5 Simple Circuits

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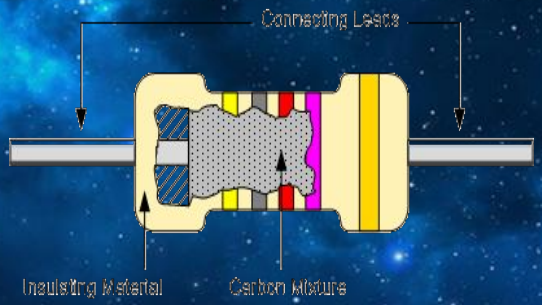
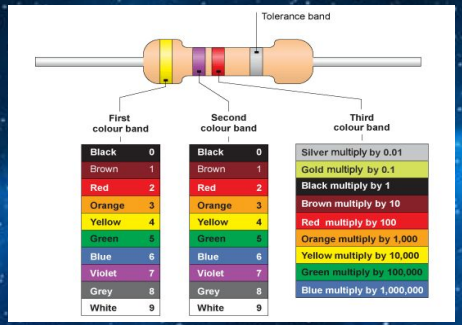
#3.1 Resistors





Resistors limit the flow of an electrical current within a circuit. There are three main types of resistors: fixed, variable and special resistors.

Fixed resistors: are the most commonly used ones: they protect components such as LEDs from being damaged by too much electricity flowing through the circuit.
Variable resistors: allow you to modify the current passing through a circuit e.g. to control the volume of the sound coming out of a speaker.
Special resistors: restrict the flow of electricity depending on temperature or light.

The power of a resistor is measured in ohms. Fixed resistors have coloured bands to show what their resistance is.

Top Tips

- Make sure that you have the right resistor as different resistors can change the current dramatically whereas some only affect the current by a few ohms

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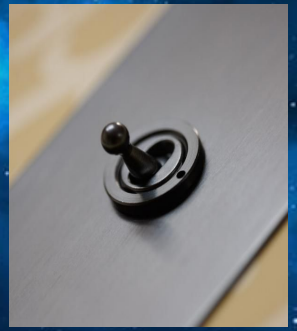
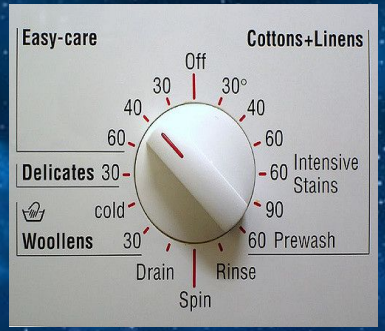
#3.2 Switches





Switches are used to turn the current of electricity on or off. When the switch is on, electricity can flow through the circuit, when the switch is off, the circuit is broken and no electricity flows through. There are many types of switches, the most common of which are:

Toggle switches: are on or off and stay that way until changed. They are commonly used as light switches.
Push switches: are only on when pushed and held, if you let go they will turn off (e.g. a doorbell). They usually have a spring mechanism inside that, when released, will return them to their off position.
Selector switches: allow you to choose from a number of different options depending on the position of the switch (e.g. an electric fan or a washing machine).

TOP TIPS

Top Tips

- When using switches make sure that you do not continuously flick them on and off as this can short the circuit.
- Make sure when you are changing switches to cut the power or you may get an electric shock.

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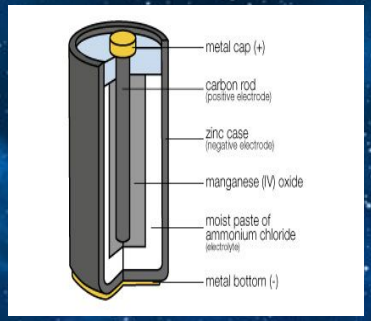
#3.3 Batteries



Batteries come in all sorts of shapes and sizes and can be used for many different things. From tiny button cells for watches to Tesla Mega batteries that power parts of Australia. Common household batteries come in five main sizes: AAA, AA, C, D and PP3. These are all 1.5 volts except for the PP3 which has 9 volts.

There are three main parts to a battery: an anode (-), a cathode (+), and the electrolyte (a liquid or gel). When the battery is connected to a circuit, a chemical reaction is caused which causes electrons to move from the cathode to the anode. This causes a buildup of electrons at the anode, which means if the battery is connected to a circuit, the electrons will flow through the circuit back towards the cathode, powering anything that the battery is connected to.

TOP TIPS

Top Tips

- Check your batteries often as when batteries are dead they can start to leak battery acid which will ruin your device. It is simple to check them with a battery checker which can be purchased from most supermarkets or online.

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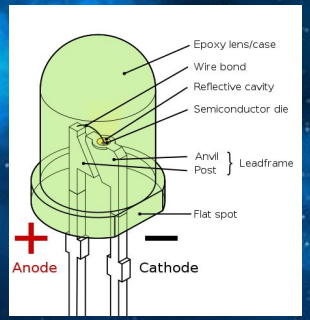
#3.3 Batteries

Here are some of the more common types of battery and the materials they are made of:

Type of Battery	Where Used	Anode (+) Material	Cathode (-) Material	Electrolyte Material
Zinc Carbon	Household batteries (e.g. Duracell)	Carbon	Zinc	Ammonium Chloride
NiCd	Older rechargeable batteries	Nickel Oxide-Hydroxide	Cadmium	Potassium Hydroxide
NiMH	Newer rechargeable batteries	Nickel Hydroxide	Various Metals	Potassium Hydroxide
Li-ion	Mobile phone batteries	Lithium Cobalt Oxide	Graphite	Ethylene Carbonate containing Lithium ions
Li-Polymer	Drone batteries	Lithium Metal Oxide	Carbon	Solid Polymer

#3.4 LEDs



LED stands for light-emitting diode. A diode is an electronic component that only lets electricity flow one way this means that it has polarity. It has a special type of diode that glows when electricity passes through it. They are made from a semi-conducting material called gallium arsenide phosphide. You can get them in a range of colours and some can switch between two colours (bi-colour) or three colours (tri-colour).

LEDs are very small so can be used for a huge variety of devices (e.g. digital clocks, remote controls and watches) and despite their small size they let off lots of light. LEDs are more efficient than incandescent and CFL light bulbs and offer energy savings of up to 90%. LEDs last longer than other bulbs, having a life span of up to 50,000 hours. They also let out little heat and are therefore safer and more eco-friendly.

Top Tips

- When using LEDs make sure that the wires are connected to the correct part. Each LED has a negative (the shorter wire) and a positive (the longer wire) coming out of it. If you get the wires round the wrong way the LED won't work.

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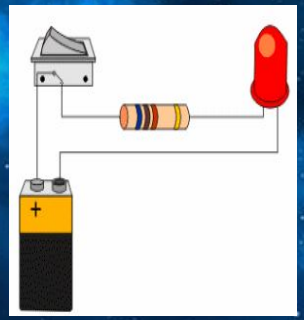
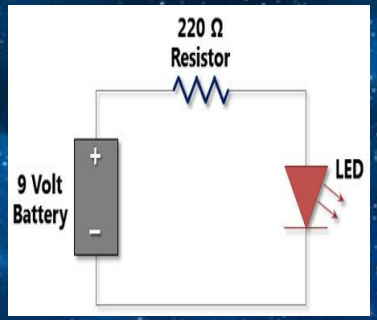
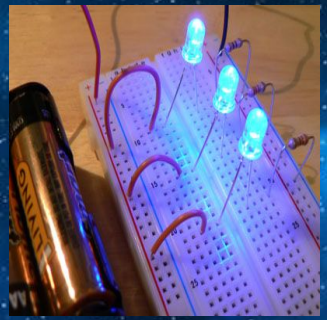
#3.5 Simple Circuits







Simple circuits usually consist of the following components:

- LEDs
- Resistors
- Switches
- Batteries

These components give you a simple lighting circuit where the battery supplies the electricity, the switch controls whether the light is on or off, the resistor controls the brightness and the LED provides the light.

There are two types of circuit: parallel and series. Series circuits have many bulbs lined up in a row and if one bulb goes out, or the wire snaps all the bulbs will go out. However, with a parallel circuit if the same thing happens only one bulb will go out and the others will continue to work.

Top Tips

- Make sure that all the components are connected together on a series circuit. If there is even one tiny gap the circuit will not work.
- If you have lots of different components in your circuit, make sure you have enough batteries so that they can all work efficiently.

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#4 Tools

- #4.1 Soldering Iron
- #4.2 Laser Cutter
- #4.3 Line Bender

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#4.1 Soldering Iron

There are two main parts to a soldering iron: the front which is a metal nib that gets very hot so you should never touch it, and the handle which is covered in a rubber heat insulator to stop you being burnt.

The metal nib should always be cleaned prior to and after use, to ensure any excess solder is removed. A damp sponge is recommended for this as any other material might burn if the solder is hot. When cleaning the metal nib after use, you must ensure that any excess water from the sponge is wiped away otherwise the nib may rust.

Top Tips

- Make sure when you buy a soldering iron, that the tip is of a good quality so that it is less likely to melt or rust.
- Always return the soldering iron to its stand when not in use. Never just leave it on the workbench or it could start a fire.

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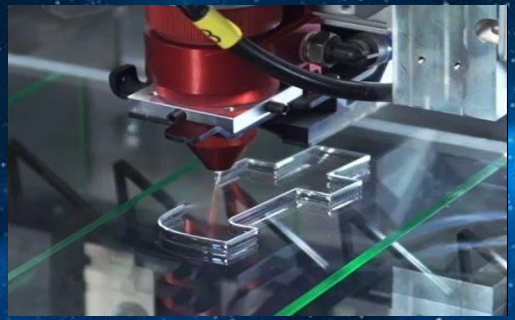
#4.2 Laser cutter



Top Tips

- Make sure that the material you are cutting in your laser cutter is positioned in the right place.
- Ensure that your design does not have overlapping lines, otherwise the laser cutter will cut that area twice, burning your material.

There are three main types of laser cutters these each have their own uses:

CO_2 Lasers: this is the most widely used type of laser cutter and is used for cutting softer materials suchs as wood, plastic, glass, paper, textiles and leather. It sends a spark through carbon dioxide to make a narrow laser beam.

Fibre Lasers: these use tiny glass fibres that are injected with electricity to create a very fine laser beam. This type of laser cutter is used mainly for engraving metal. It is over 100 times more intense a beam than that created by the CO_2 laser.

Crystal lasers: this is similar to the fibre laser in that it creates a very fine beam and can be used on metals, however, it is more expensive and has a shorter life-span.

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#4.3 Line Bender

Line benders are used to make simple, straight bends in sheets of thermoplastic.

When the thermoplastic is heated it softens enough so that the plastic is bendable, at this point you have to grab the edges furthest from the heated part and then bend the plastic into the shape. You must hold or clamp the bent plastic in position until it cools, otherwise it will not maintain its shape.

Line benders can get to temperatures of around 200 degrees celsius. This is very hot so you have to be careful about where you put your hands when using a line bender or else you could get a serious burn.

Top Tips

- Make sure that you keep your fingers away from the heated part of the line bender
- Hold the bent plastic until it has cooled to ensure it maintains its desired shape.

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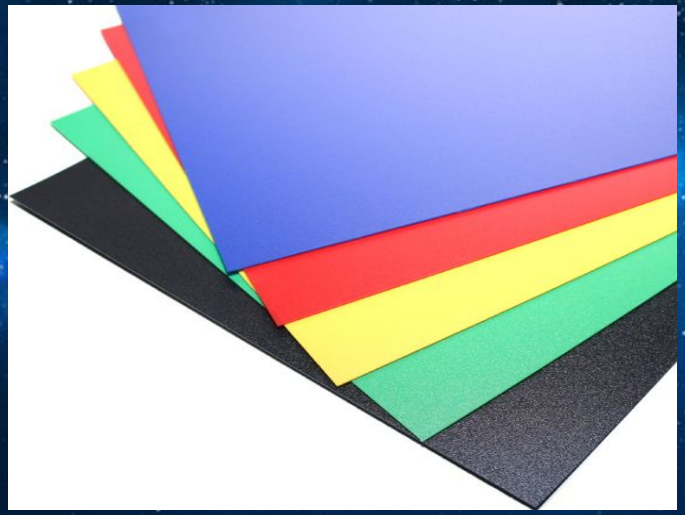
#5 Materials



- #5.1 Thermoset plastic
- #5.2 Thermoplastic
- #5.3 Solder

#5.1 Thermoset Plastic

Thermoset plastics are a type of plastic that once they are heated and moulded into their first shape, cannot be turned into another item. Thermoset plastic is stronger than thermoplastic as it is made to withstand heat. Examples of thermoset plastics are:

Melamine plates: thermoset plastics are used to make children's and picnic plates so that if they are dropped, they are less likely to smash or crack

Laminate Work surfaces: kitchen work surfaces are often made of melamine as this plastic is hard, strong, resistant to heat, does not stain easily and does not react to spillages

Electrical Equipment: plugs and sockets are often made of thermoset plastics as they can withstand high temperatures, will not melt or make the electrical fitting hot to touch

Luggage: thermoset plastics are also used to create items such as luggage and packaging as it is very light weight.

#5.2 Thermoplastic

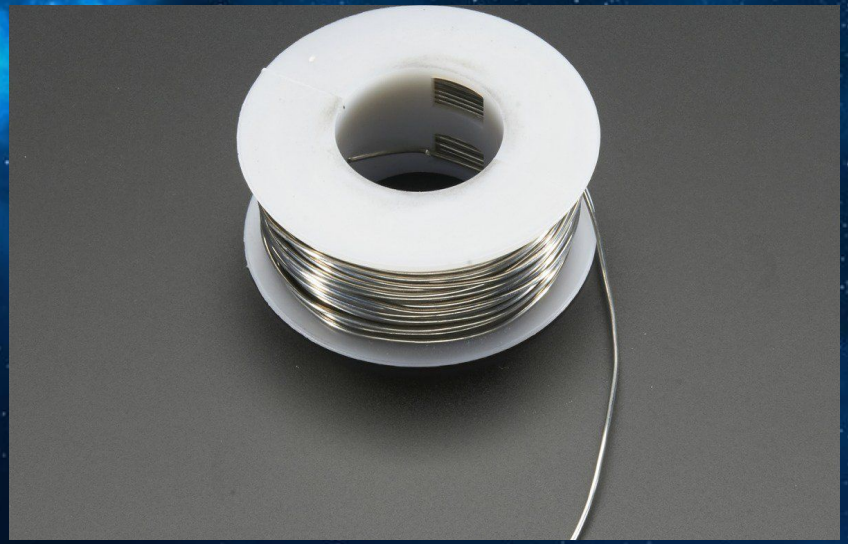
Thermoplastics are plastics that once moulded, can then be reheated and remoulded into a new item. The way this plastic works is that it melts in heat and hardens in the cold. It is not as strong as thermoset plastics, as if heated to a very high temperature, thermoplastics can turn back into liquid. Examples of thermoplastics are:

Plastic chairs: thermoplastics are used to create items such as plastic chairs as it is resistant to water spillages and is a very strong and lightweight plastic

Toys & Plastic Containers: although the plastic is quite brittle and can sometimes be snapped, it can easily be moulded into detailed shapes, is lightweight and resistant to water

Water bottles: water bottles are often made with thermoplastics as this keeps them lightweight, moldable and resistant to leakages. Thermoplastics are ideal for using for this type of product as when the water bottle has been used, it can easily be recycled and made into a new product.

#5.3 Solder



Solder is used to create a permanent connection between two pieces of metal. Solder comes from the Latin word “solidare” which means “to make solid”. Solder typically has a melting point of between 183 and 450 degrees depending on how soft or hard the piece of solder is. You can buy solder in a range of different thicknesses depending on what you are using the solder for.

Solder is a conductor so when you use it on wires the electricity can pass through it. There are two types of solder:

Lead-Free Solder: this does not have lead in it. It is most commonly used in order to avoid the health risks linked with lead.

Lead-Based Solder: this is not commonly used nowadays due to the health risks involved. It is a mixture of tin and lead.

#6 Safety

#6.1 Soldering Iron Safety

Soldering irons can get very hot, up to 450 degrees celsius in temperature. In order to avoid the risk of first degree burns, you must always hold the soldering iron by the rubber insulated handle, never the metal tip.

When the soldering iron is not in use, the tip can still be hot, so you should always make sure that you hold the iron by the handle and that no part of your finger touches the metal nib.It is also important to never touch the melted solder as this can get stuck to your skin and will continue to burn you.

To prevent the risk of fires, whenever the soldering iron is not in use, it must be stored in its stand and not just left lying on the workbench.

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#6.2 Laser Cutter

Laser cutters can be very dangerous if they are not used correctly. If the protective glass is not down the invisible highly concentrated beam can severely damage and even blind you if it is shone in your eyes. It can also cause serious skin burns so you should never put your hand on the inside of a laser cutter.

Another danger with laser cutters is that the beam is extremely hot so if any of the air vents are covered the machine can overheat and can cause fires. Laser cutters should only be used to cut materials that the manufacturer has said it can be used on, otherwise vapours and other harmful gasses might be released.

To help prevent these problems you must always wear gloves, ear protection and, most importantly, safety goggles.

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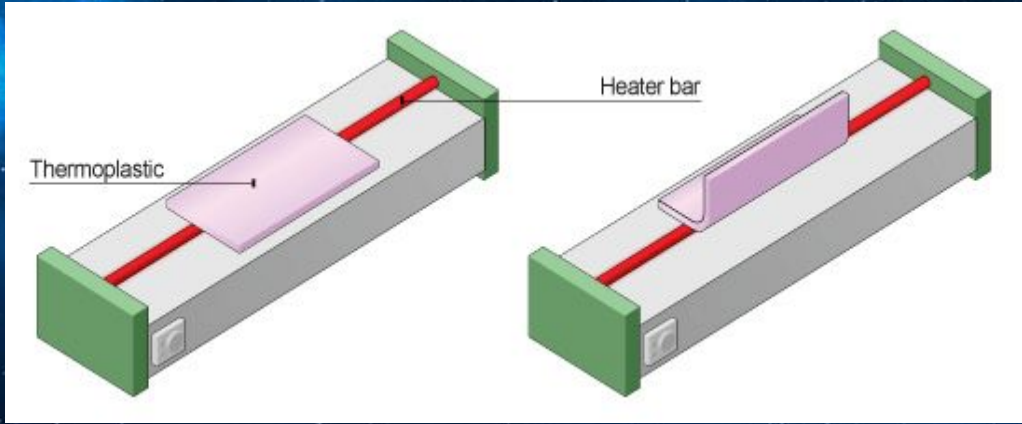
#6.3 Line Bender



There are three main dangers with line benders:

The heat given off by the machine as it softens plastic can cause serious burns. To prevent accidental burns, you should always wear heat proof gloves when using a line bender..

Line benders also give off fumes when heating plastics, so you should always wear a mask to prevent you from breathing these in.

Finally, as with all electrical equipment, there is the risk of electric shocks. Always check your machinery prior to use to ensure that ensure the wires are properly insulated with no cracks in them and that water is kept away from your working area.

#7 Research

#7.1 Space Research

#7.2 Desk Lamp Research

#7.3 Thumbnail Sketches

#7.4 Developed Ideas

#7.5 Final Idea

#7.6 Final Idea With Wiring

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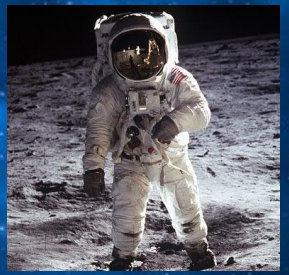
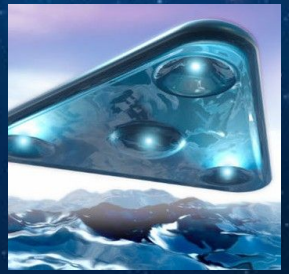
#7.1 Space Research





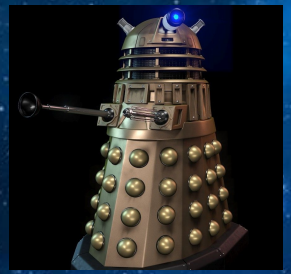



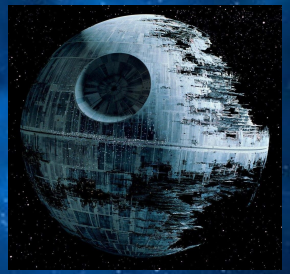




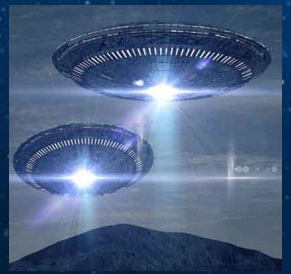
#7.1 Space Research





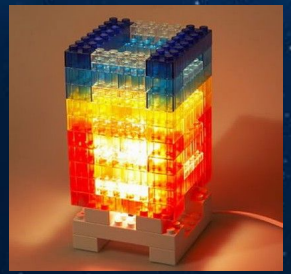




#7.2 Desk Lamp Research



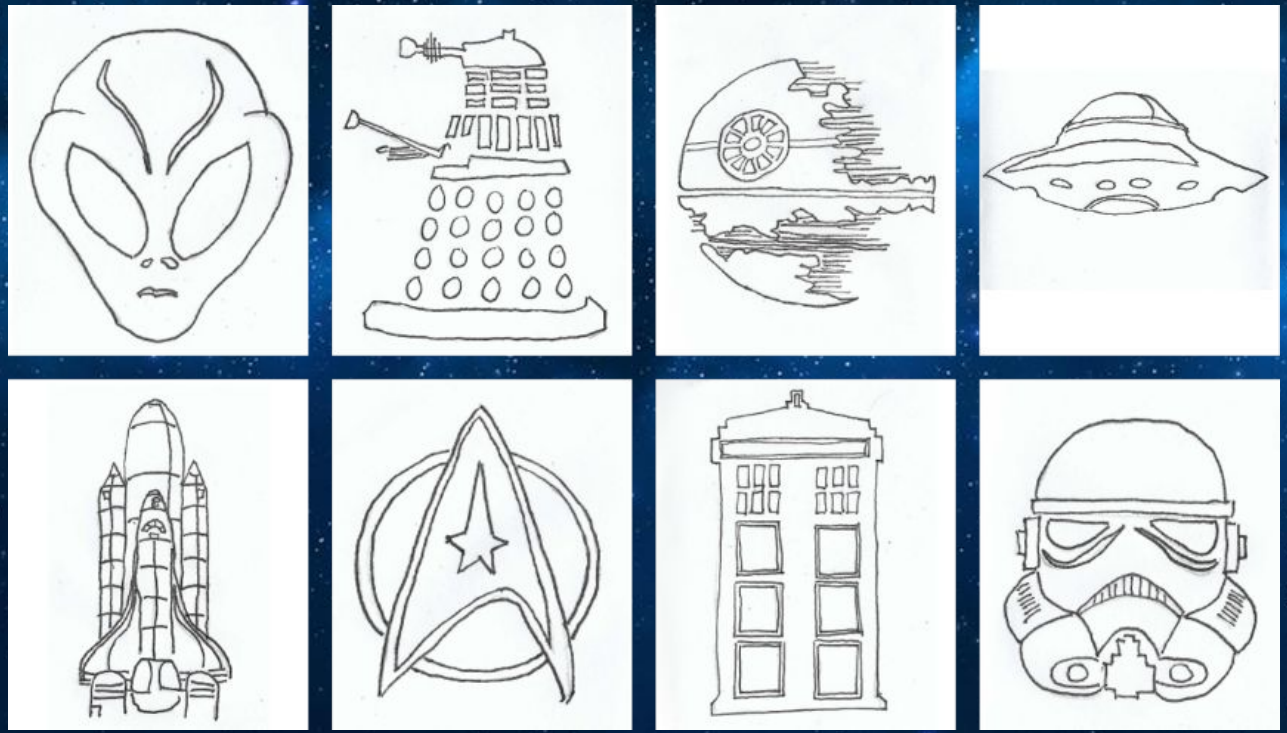




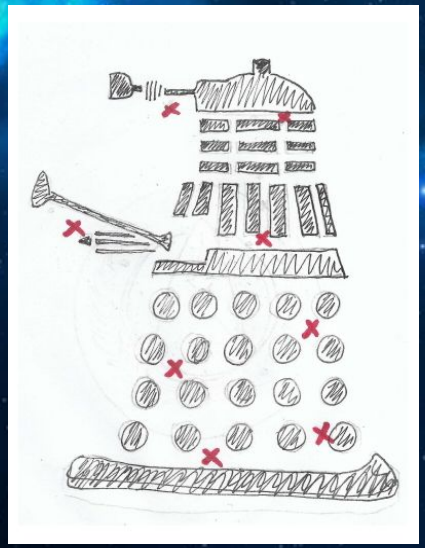



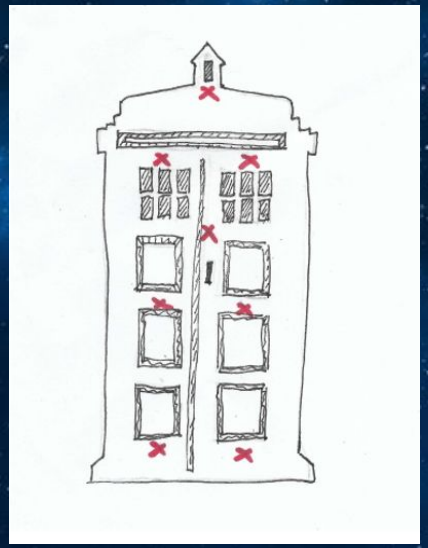


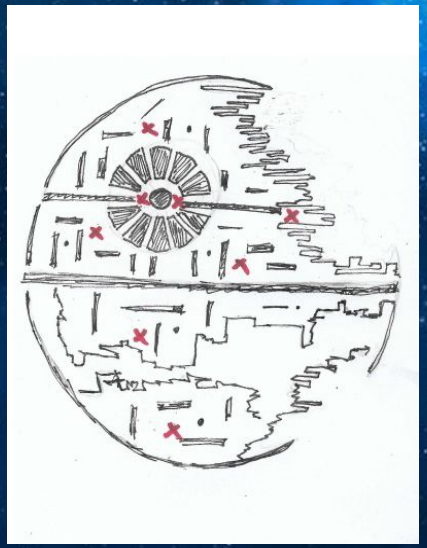
#7.3 Thumbnail Sketches



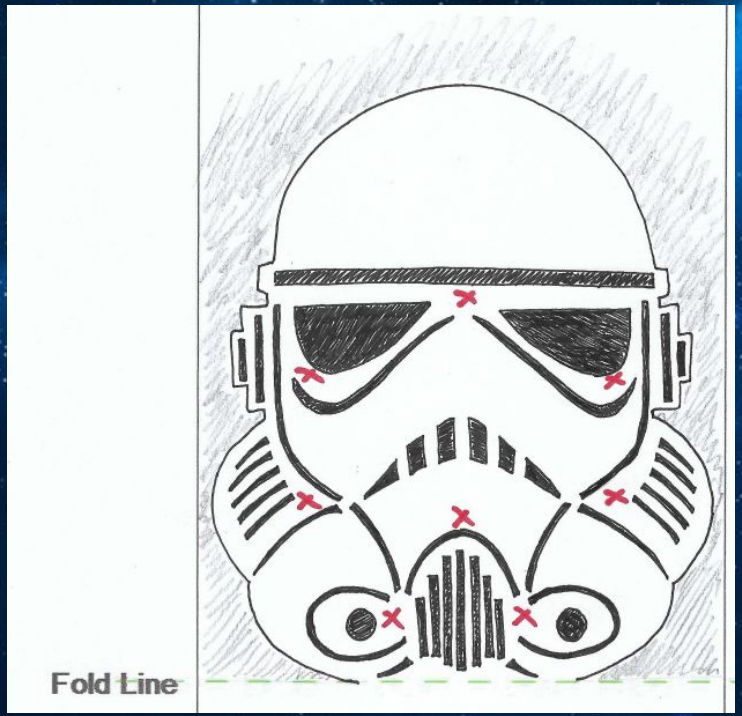
#7.4 Developed Ideas



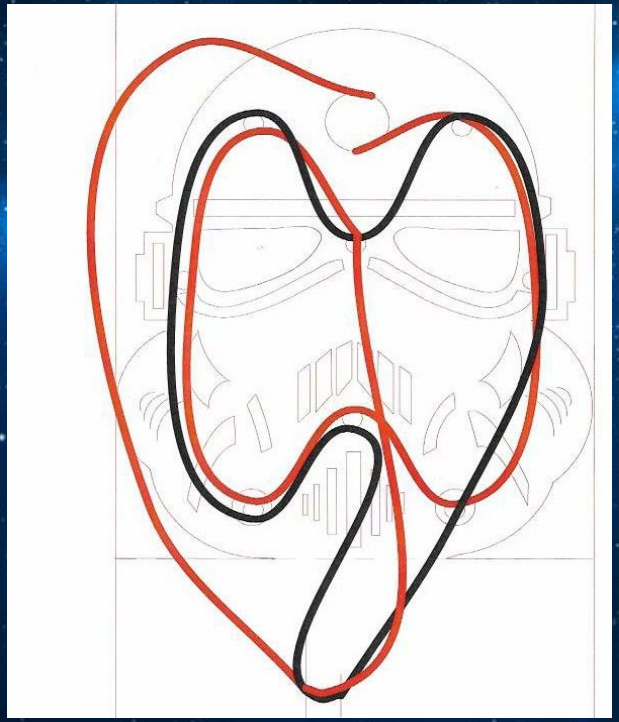




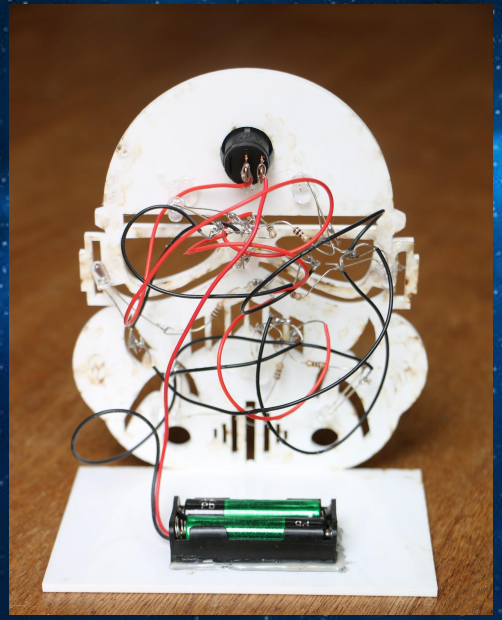
#7.5 Final Idea



#7.6 Final Idea With Wiring



#8 Evaluation



Design & Laser Cutting: When converting my design to the CAD program, I didn't realise there were options to copy and flip the design in order to make it symmetrical. If I had used this, the lamp would have resulted in a slightly better overall finish. The laser cutting went well.
Material: The thermoplastic used as the material to make the lamp was successful as it did not have to withstand high temperatures as LED lights were being used, and it was easy to mold the plastic using the line bender to create the base.
Soldering & Wiring: All of the wires were successfully soldered together and when batteries were added to the circuit, all of the 8 LED lights successfully lit up. I possibly could have stuck the LED lights to the back more successfully if I had used a different type of glue.

Overall the project went well and I am pleased with the final product.

#9 Bibliography

http://www.dfliq.net/electrical-materials-products/electrical-wires-cables/
https://www.distributorwire.com/blog/thhn-wire/
https://hypertextbook.com/facts/2003/LillianDvirts.shtml
http://www.modorplastics.com/plastics-learning-center/thermoset-vs-thermoplastics/
https://en.wikipedia.org/wiki/Laser_cutting
https://www.picoquant.com/applications/category/materials-science/laser-seeding
https://en.wikipedia.org/wiki/Electrical_muscle_stimulation
https://www.troteclaser.com/en-gb/knowledge/faqs/laser-types/
https://en.wikipedia.org/wiki/Solder
https://www.quora.com/What-are-the-different-types-of-solder
https://www.ehs.washington.edu/system/files/resources/laser-cutter-safety.pdf
https://teachershealthsafety.wordpress.com/risk-assesments/vacuum-forming/
https://www.cad-notes.com/100-autocad-tips-you-should-know/
https://www.sciencebuddies.org/science-fair-projects/references/how-to-solder
http://www.resistorguide.com/
https://www.thespruce.com/tips-for-identifying-light-switches-in-your-home-4122561
https://www.dummies.com/programming/electronics/how-to-build-a-simple-electronic-circuit/
https://electronics.stackexchange.com/questions/194670/what-is-the-best-tips-to-use-while-soldering
http://www.bbc.co.uk/schools/gcsebitesize/design/electronics/manufacturing_processesrev5.shtml