School Amateur Radio Club Activity Sheet

Electronics Kit Construction – The Hypnotic Owl

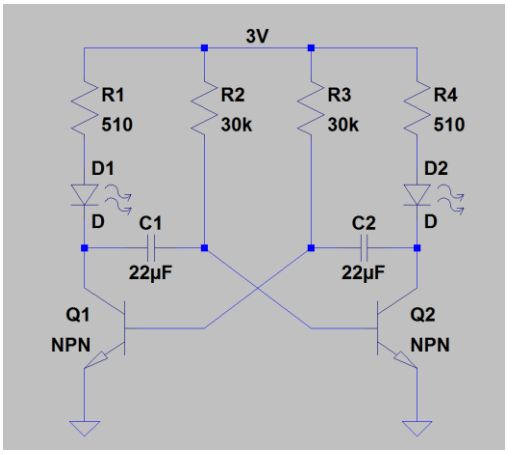
Learn how to construct inexpensive electronic kits for your own projects with this fun activity. Build your first electronics kit by soldering components to a printed circuit board. In this activity sheet you will make an electronic flashing light circuit. It has two blue Light Emitting Diodes (LEDs) and all the components required to make them flash on and off in a hypnotic pattern. You can make the hypnotic owl model by cutting out and pasting the owl picture onto some cardboard, pushing the LEDs through the eye holes and attaching the battery case with double-sided tape for the base. Have fun!

Warning

This kit requires the use of a very hot soldering iron, molten solder and sharp wire cutters. Constant adult supervision is required and safety equipment must be used. Do not use any tools until instructed to do so. Observe all safety instructions in this document.

How it works

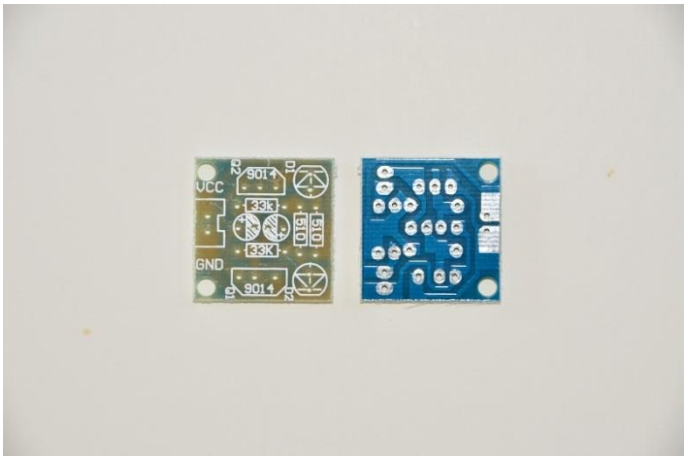
Connect a 3 volt battery to this simple circuit and the cross-connected transistors Q1 and Q2 turn on and off alternately several times every second. This causes the LEDs D1 and D2 to flash. The resistors R1 and R4 set the maximum safe current that will flow through the LEDs. The resistors R2 and R3 and the capacitors C1 and C2 set the flashing rate. This famous circuit is called an “Astable Multivibrator” since once it starts flashing it just can’t stop!



Electronic Circuit Schematic of an Astable Mutivibrator

What you need

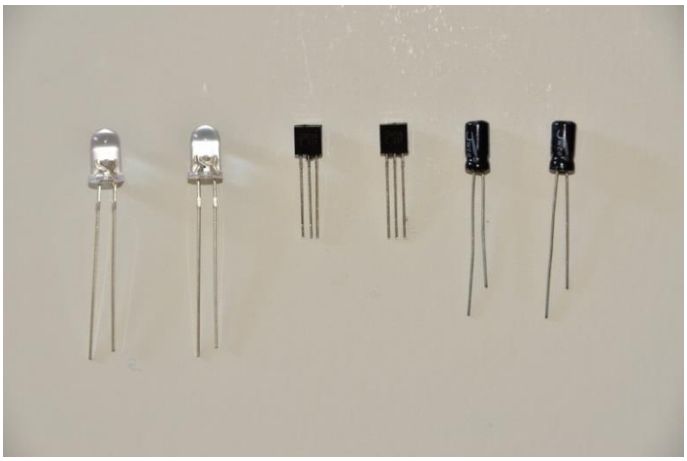
1. The Printed Circuit Board (PCB). This PCB connects all the electronic components together and holds them in place. It has two sides: The green side for the components and the blue side for the printed circuit solder pads. There is a white screen-printed component overlay on the green side showing which components go where. There are tiny holes through the PCB which allow the component leads to be inserted. On the blue side of the PCB there are copper circuit tracks covered by a blue solder mask, which has openings in it for the shiny, tin-plated solder pads. The board itself is made of fibre-glass so be careful of any prickly bits on the edges.
2. The resistors. There are two (2) of each type. They have coloured bands to indicate their values: Green Black Brown for the 510 ohm resistor and Orange Black Orange for the 30k ohm resistor. Note: The 30k ohm resistor is used instead of the 33k ohm resistor shown on the PCB component overlay. The resistors can be inserted into the PCB in either direction, but it is customary to align all the colours in the same way.



Printed Circuit Board

Resistors

3. LEDs, Transistors and Capacitors. The LEDs have a clear plastic housing and two leads. The transistors have a black cylindrical housing with a flat face and three leads. The capacitors have a black cylindrical housing as well, but only two leads. These components must be inserted into the PCB in the correct orientation. Each component has a longer lead or a flat face to help identify the correct direction.
4. Battery case and batteries. The battery case has a switch and two wires. It can be slid open and two AA size batteries inserted. The orientation of the red and black wires on the PCB is very important. **Caution: Do not put the batteries in the battery case until the wires are correctly soldered to the PCB.**



LEDs, Transistors and Capacitors

Battery case and batteries

Tools

1. Soldering Iron. The soldering iron has a metal tip and barrel and a plastic hand grip. The tip and barrel get hot enough (360°C) to melt metal solder so it must always be held by the plastic hand grip an placed in the soldering iron stand when not in use. **Caution: Do not touch the hot soldering iron tip or barrel. Do not let the hot soldering tip or barrel touch anyone or anything else other than the PCB and the solder. Do not flick the hot soldering iron to remove excess solder or for any reason. Return the hot soldering iron to the soldering iron stand immediately after use. Unplug the soldering iron when not in use. Allow the hot soldering iron to cool for 10 minutes before packing it away.**
2. Soldering Iron Stand. The soldering iron stand holds the soldering iron when it is not in use. It gets hot too, but not enough to burn. **Caution do not knock the hot soldering iron stand over.**

Soldering Iron

Soldering Iron Stand

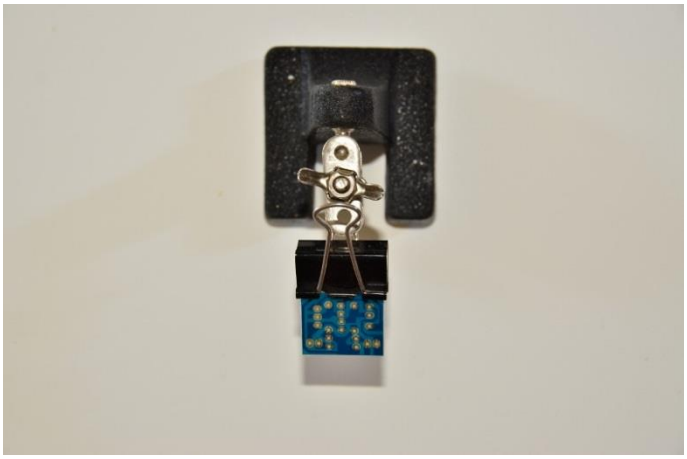
3. Soldering Iron Tip Cleaner. The hot soldering iron tip quickly builds up excess solder and residues from the soldering flux and other impurities. The tip needs to be perfectly shiny for good soldering. The tip cleaner is just a metal pot scouring pad in a heat resistant container. Plunging the hot soldering iron tip in and out of the pad quickly cleans off any excess solder and burnt flux residue.
4. Soldering Wire. Resin-cored soldering wire is just the thing for soldering small electronic components. It comes on a reel and can be bent into any position. The wire is made of tin and lead and has a relatively low melting point. The lead part of solder is safe so long as it is not ingested (eaten or sucked) and should be handled with gloves just to be sure. The soldering wire contains a core of resin powder, which melts when the solder comes into contact with the hot soldering iron tip. The resin acts a flux to clean oxides and impurities from the metal surfaces of the soldering iron tip, the solder pads and the component leads. Soldering can be quite difficult without the proper flux, which really helps ensure good shiny solder joints. But the flux resin quickly boils and burns and it causes an acrid smelling smoke. **Caution: Do not deliberately breath in the concentrated solder flux smoke. Take a breath before you solder or use a fan or natural air movement to gently blow the smoke away from your face.** It is always a good idea to clean an adequate length of soldering wire with a tissue before use to remove any oxides and impurities from its surface.

Soldering Iron Tip Cleaner

Soldering Wire

5. Pliers and Wire Cutters. Pliers are sometimes used to bend component leads or to hold components while soldering. Wire cutters are used to cut component wires to the required length. Always keep the flat side of the cutters towards the PCB so that the end of wire remaining is cut flush. **Caution: Wire cutters are sharp like scissors and cut wires fly off in all directions so wear safety glasses and make others stand well back.**
6. PCB Holder. The PCB holder is used to hold the PCB firmly, pad-side up, during the soldering operation. A PCB holder can be made from a bulldog clip attached to any stable base.

Pliers and Wire Cutters



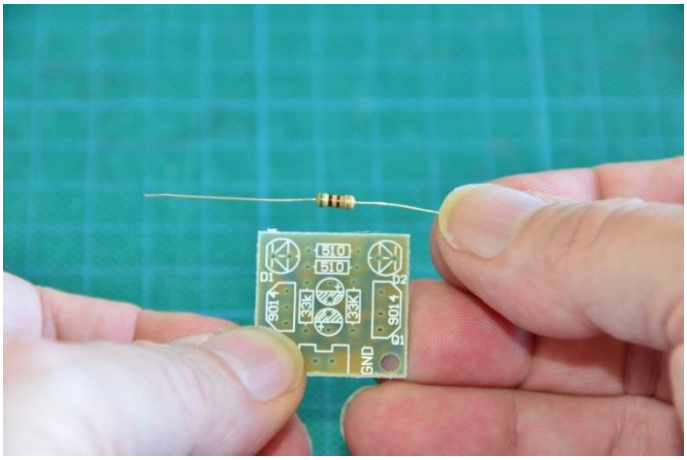
PCB holder

7. Component Tray and Soldering Mat. A component tray is useful to store all the small electronic components prior to their final assembly on the PCB. Any suitable container with a tight fitting lid can be used. The soldering mat, however, is essential for protecting the table top from damage. Excess molten sold could drip off the soldering iron tip and land on the mat. If that ever happens, and it should not if you follow the directions carefully, please wait for the solder to cool before trying to remove it with the pliers. Never touch the soldering mat, or anything else for that matter, with the hot soldering iron tip.
8. Safety Glasses and Gloves. Hot solder is molten metal! If it was flicked into your eye it could cause permanent eye damage. Touching hot solder or a hot soldering iron tip or barrel with your hands could cause a serious burn. However, by being aware of these dangers and following simple precautions soldering is safe under constant adult supervision. **Caution: Always wear safety glasses and woollen gloves while the soldering iron is on. All others must stand well back and observe from a distance.**

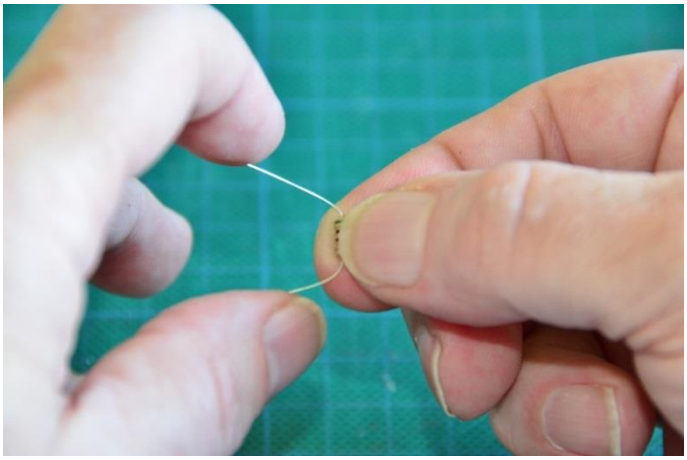
Component Tray and Soldering Mat

Safety Glasses and Gloves

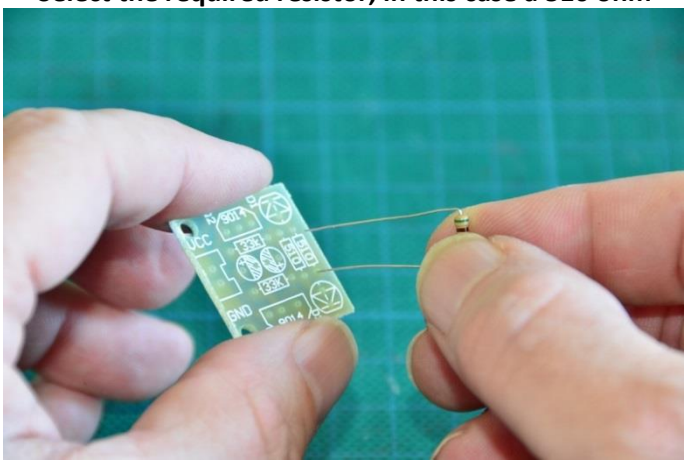
Assembly



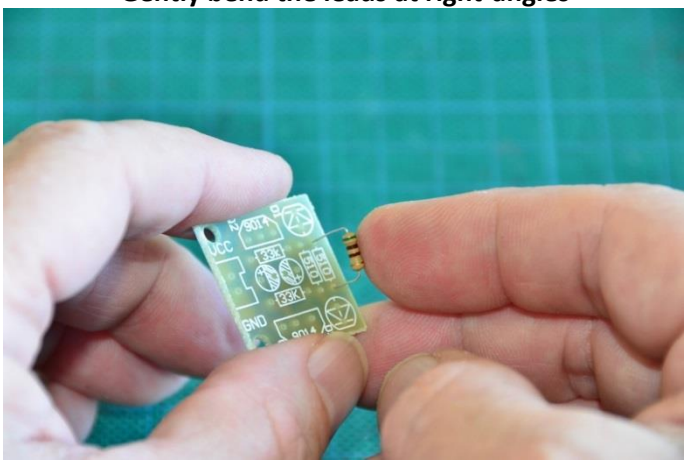
Select the required resistor, in this case a 510 ohm



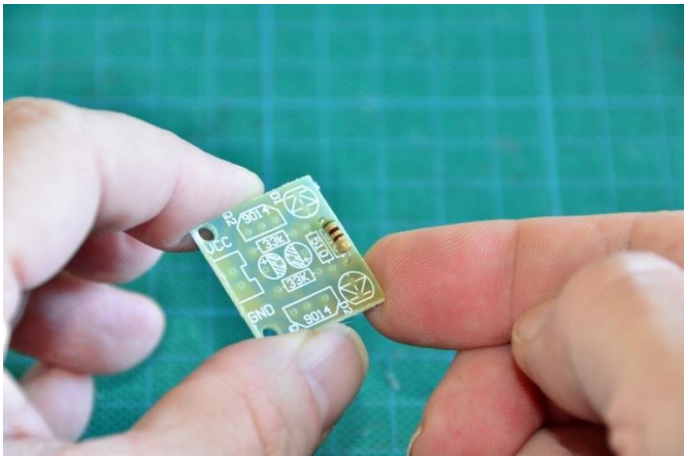
Gently bend the leads at right-angles



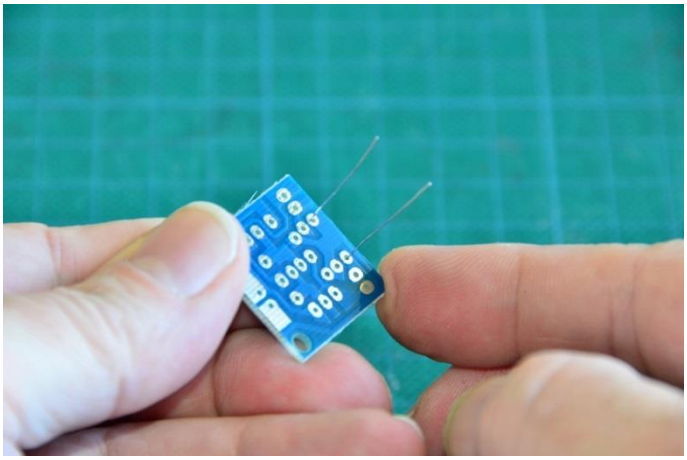
Insert the leads into the correct PCB holes



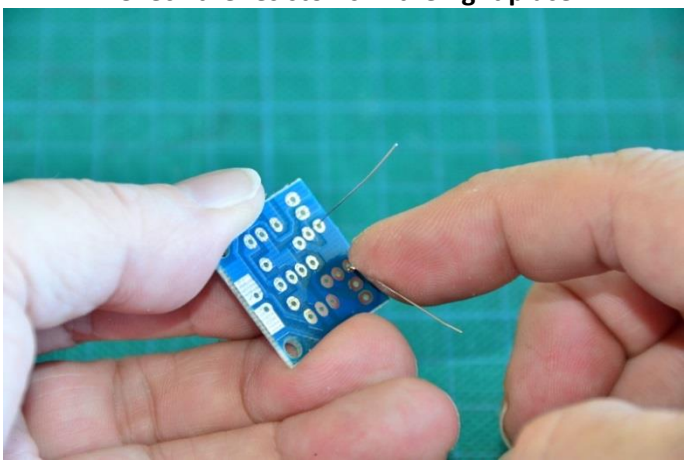
Press the resistor down onto the PCB



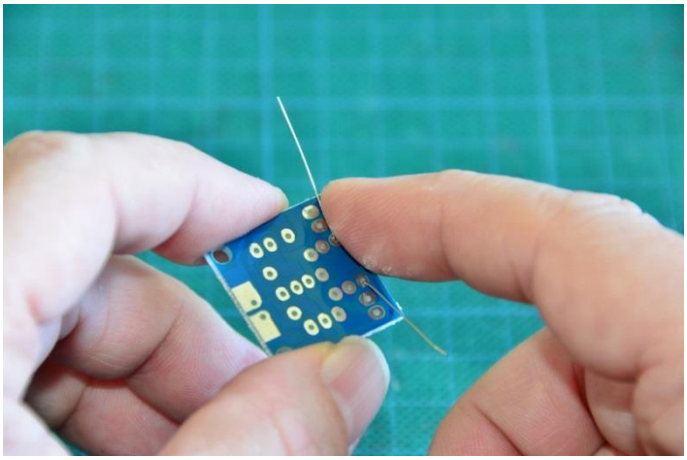
Check the resistor is in the right place



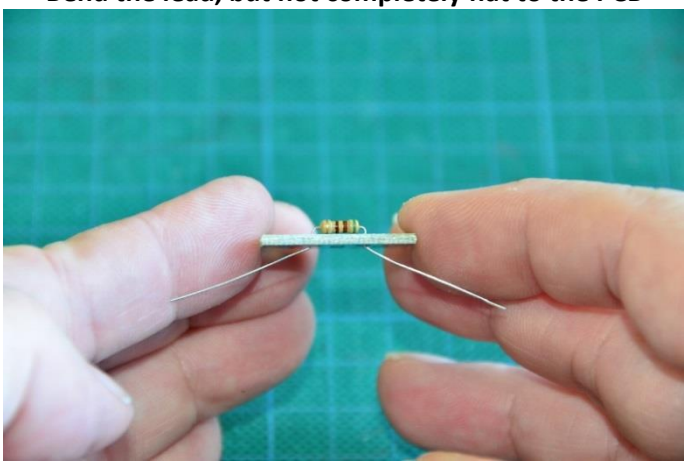
Turn over the PCB



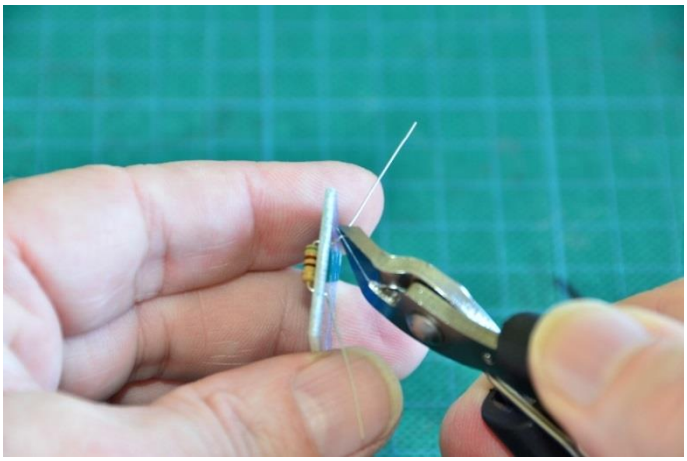
Bend the lead, but not completely flat to the PCB



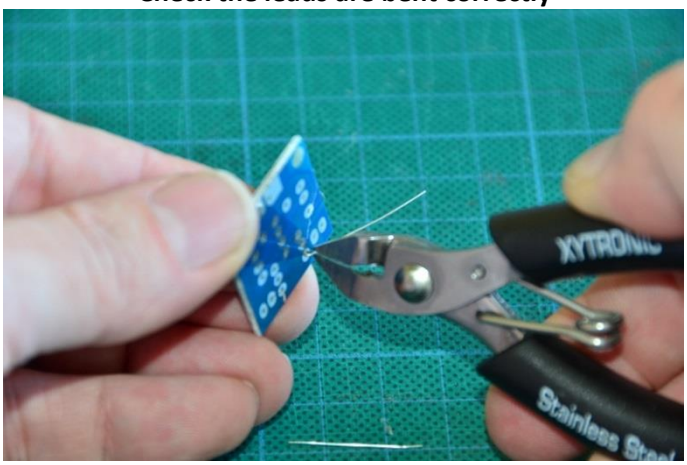
Bend the other lead



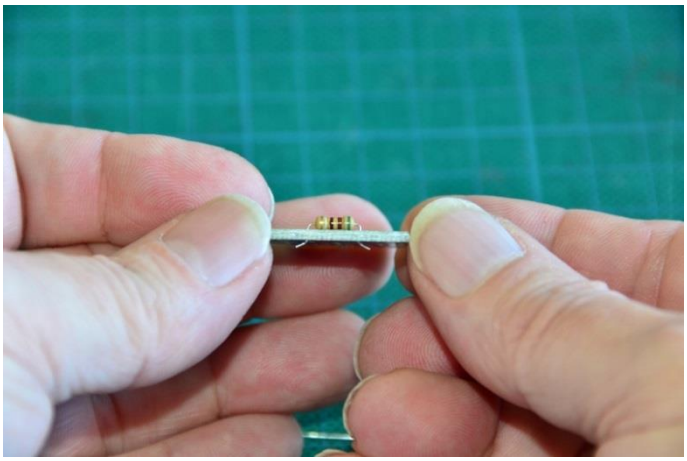
Check the leads are bent correctly



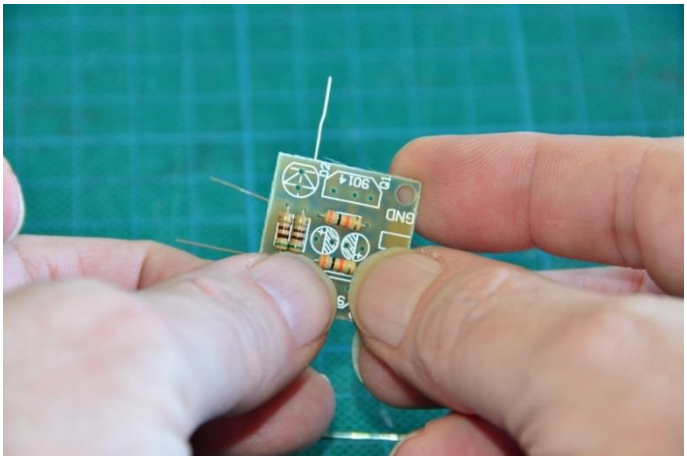
Cut the lead 2mm from the PCB



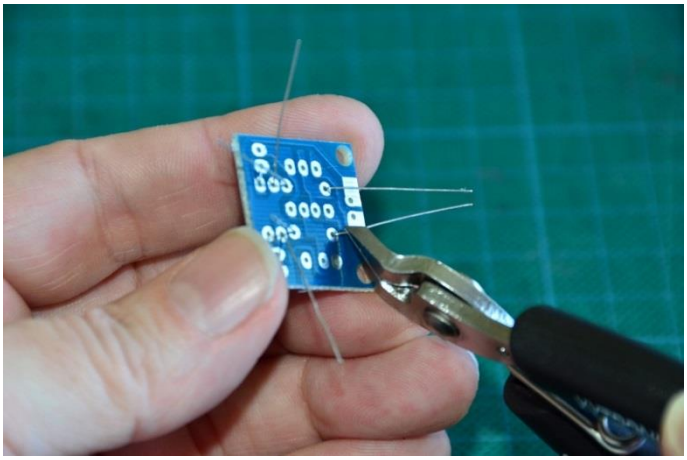
Cut the other lead the same way



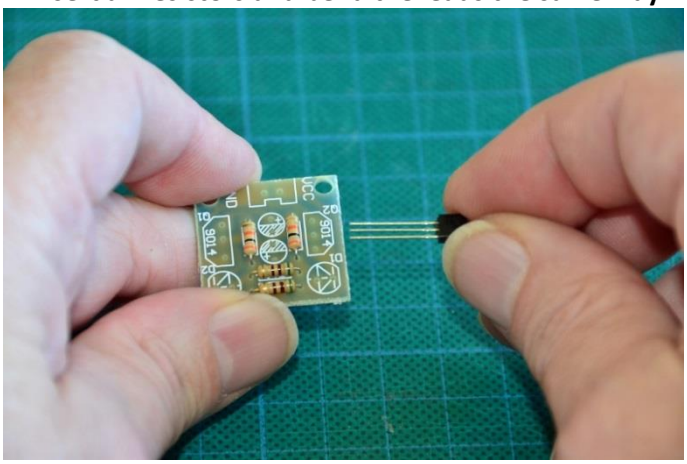
Check the leads are cut correctly



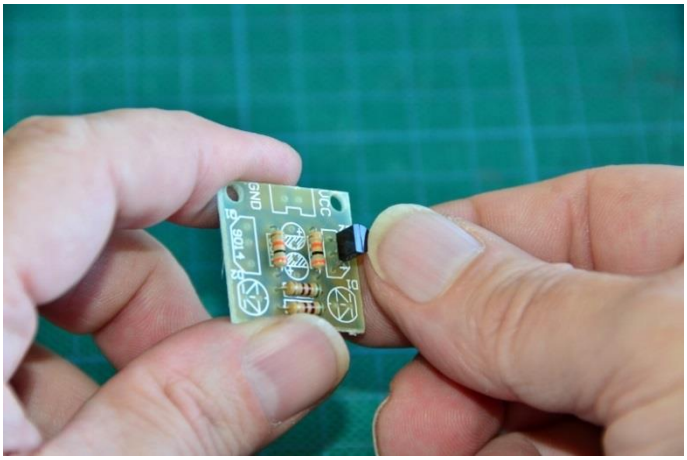
Insert all resistors and bend the leads the same way



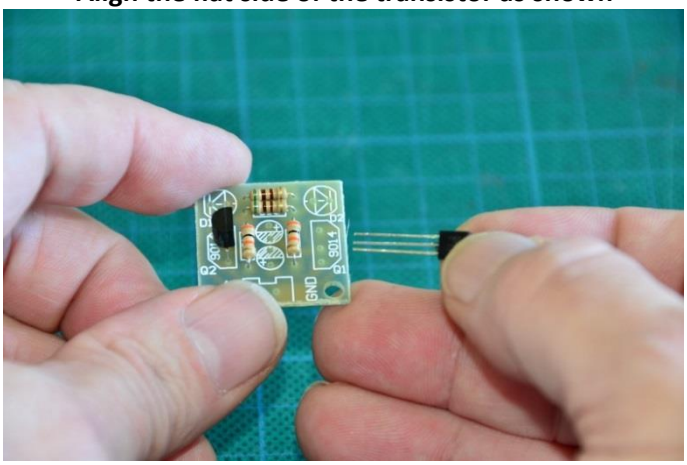
Turn over the PCB and cut all the resistor leads



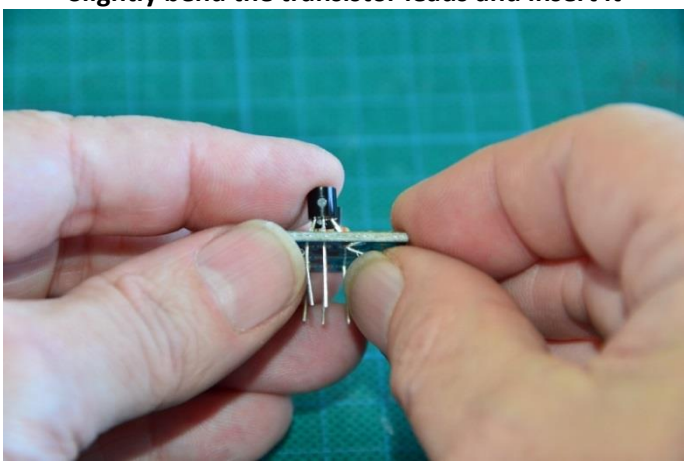
Align the flat side of the transistor as shown



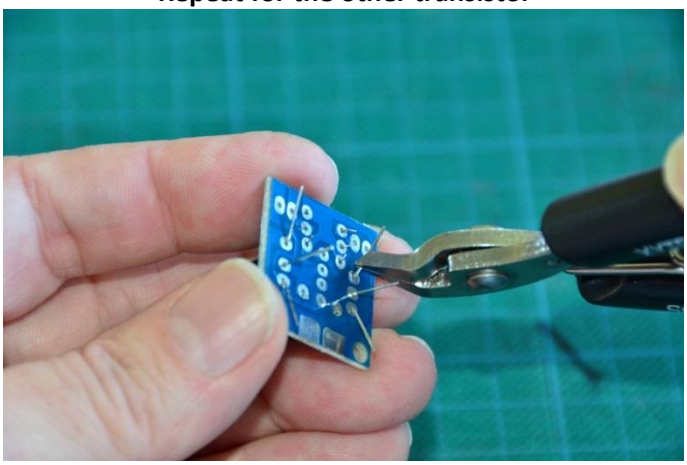
Slightly bend the transistor leads and insert it



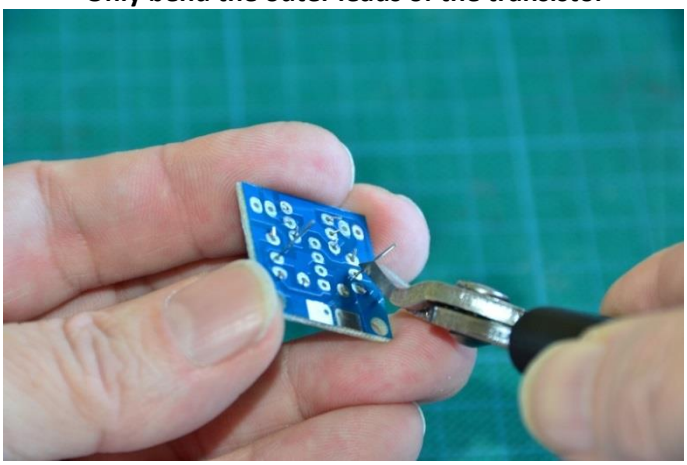
Repeat for the other transistor



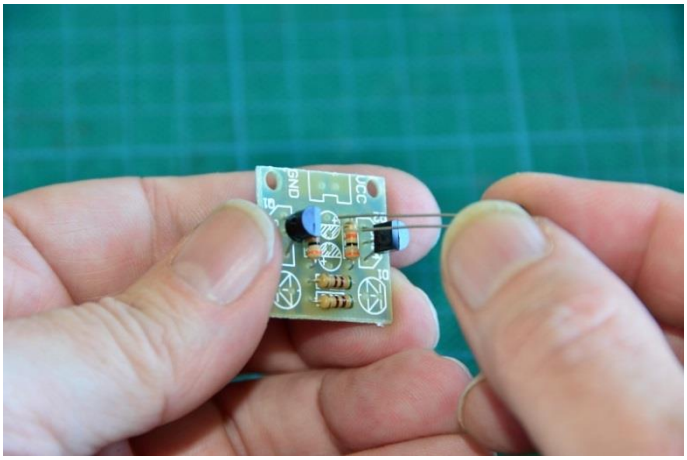
Only bend the outer leads of the transistor



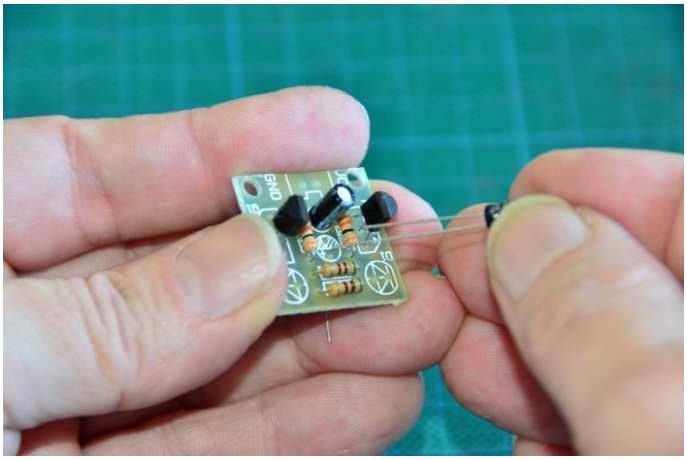
Cut the outer leads of the transistors



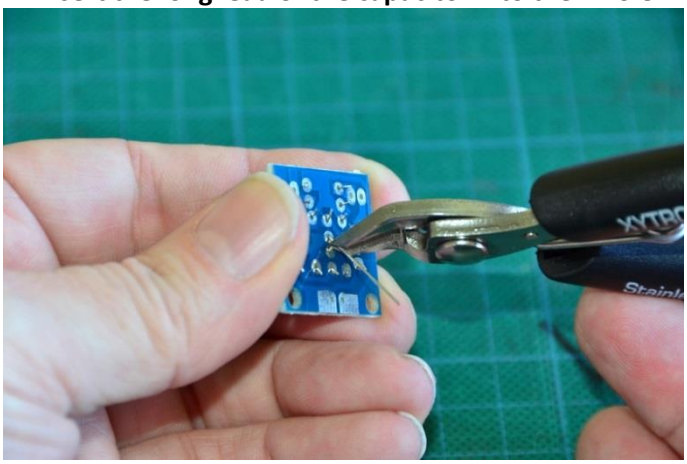
Carefully cut the centre lead of the transistors 2mm



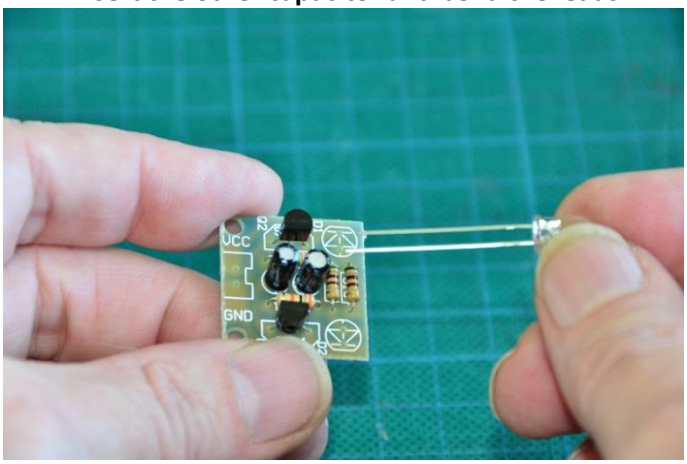
Insert the long lead of the capacitor into the + hole



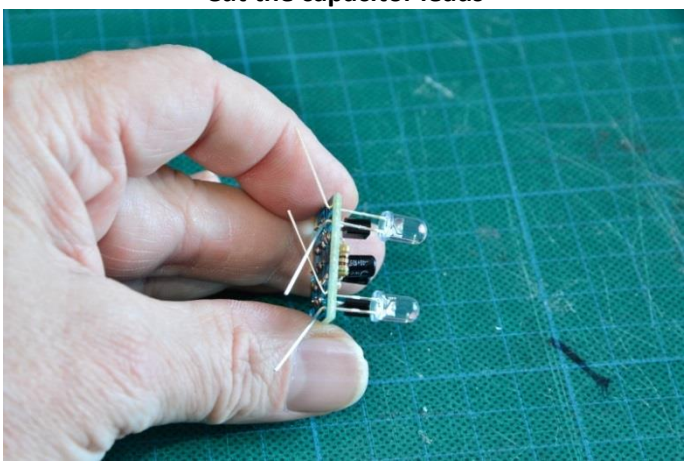
Insert the other capacitor and bend the leads



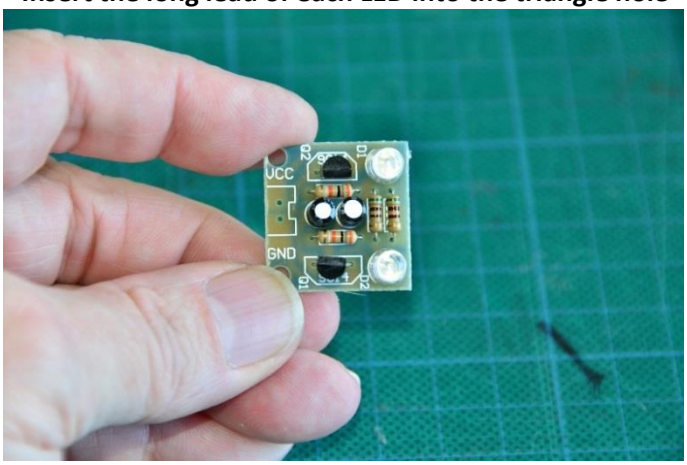
Cut the capacitor leads



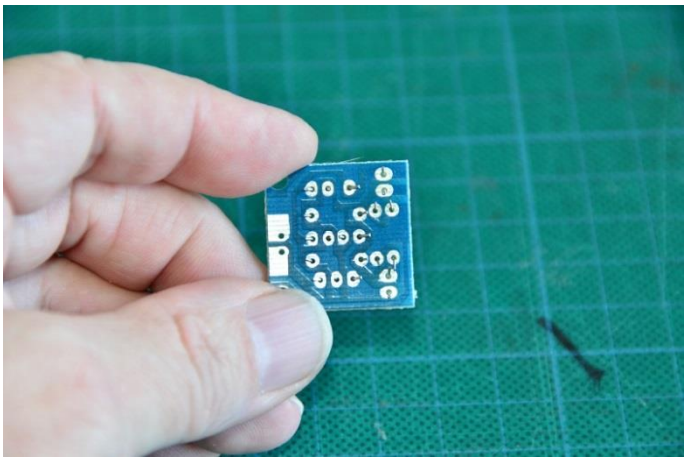
Insert the long lead of each LED into the triangle hole



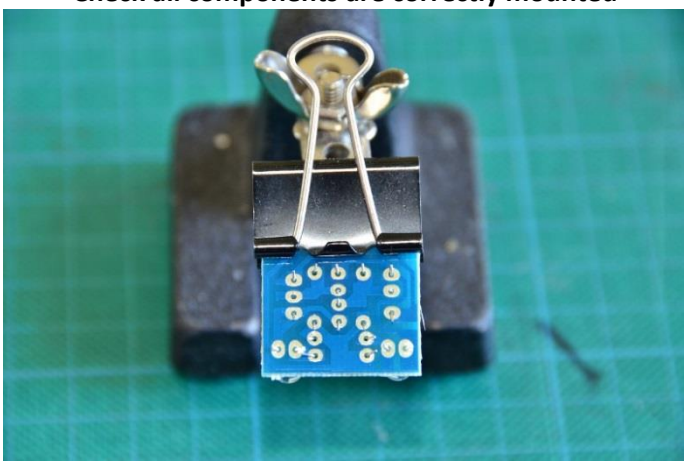
Bend and cut the leads with the LED 1cm above the PCB



Check all components are correctly mounted



Check all leads are cut. Move any touching leads apart.



Put the PCB into the PCB holder

Soldering

Caution: Review all the cautions above. Put on the safety glasses and the woollen gloves. All others must stand away from the soldering bench and observe from a distance.

Turn on the soldering iron and place it in the soldering iron stand to get hot (3 minutes). At the start of the soldering process, and at regular intervals during soldering, the soldering iron tip must be tinned and cleaned to achieve a shiny point, free from excess solder, burnt flux and residues.

Bring the solder to the tip of the hot soldering iron

Melt some solder onto the tip. The flux will smoke.

Bring the tip close to the tip cleaner

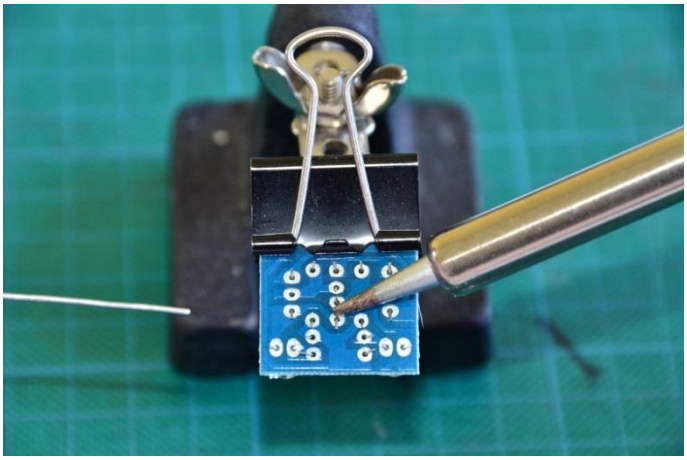
Poke the tip in and out several times

Check the tip is shiny and clean

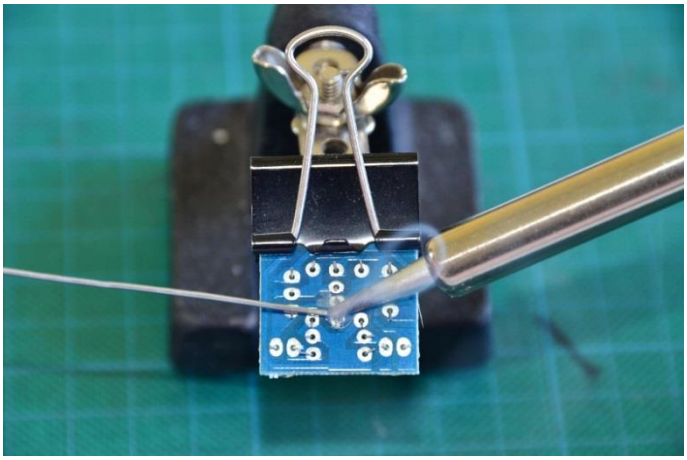
Soldering PCBs

When soldering PCBs it is important to apply just enough heat and solder to each pad and no more. The PCB pads are very delicate and can peel off the PCB if overheated. Many components are also damaged if overheated. Soldering a pad should only take a few seconds, no more than 5 seconds. If you are not finished soldering a pad within in a few seconds, quickly remove the soldering iron tip, let the pad cool down and try again in a minute.

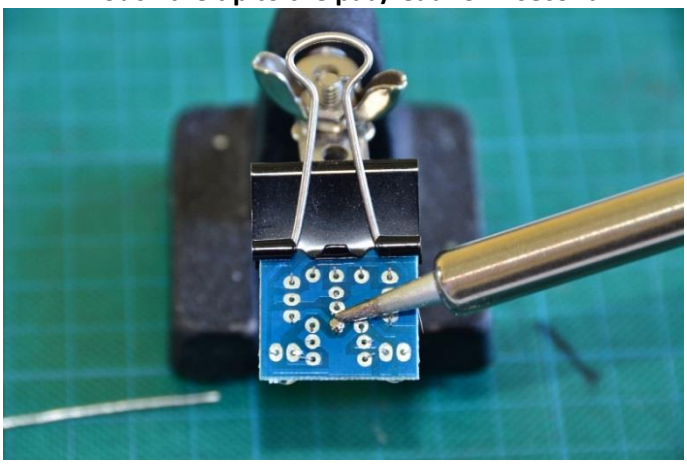
To solder a component to a PCB pad, both the pad and the component lead needs to be preheated by the soldering iron tip for a second or so. The tip has to touch both parts firmly and not touch any other pads or leads. You might have to twist the soldering iron or reorientate it to get the tip into a good position. It is a good idea to plan your attack before touching the tip to the PCB. Then the soldering wire is applied at the precise point between the tip, the lead and the pad. The solder melts and it releases its flux, which will clean the joint and smoke a bit. The solder will start to flow all around the pad and wick up the component lead. After only a second or so the soldering wire is quickly removed, when there is just enough solder to complete the job. It is important then to watch and wait for the solder flow to stop, but no more than a second. The tip is then quickly removed and the solder cools down to form a clean, smooth, shiny joint. If too little solder is applied the first time or if the joint is not shiny, the process can be repeated by applying a little less solder the second time. If too much solder is applied, forming a round blob, it can be removed by first cleaning the tip and reheating the joint with just the tip to wick up the excess solder.



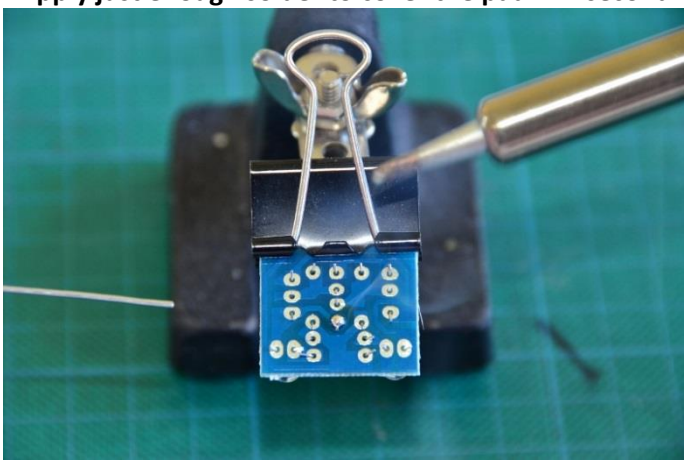
Touch the tip to the pad/lead for 1 second



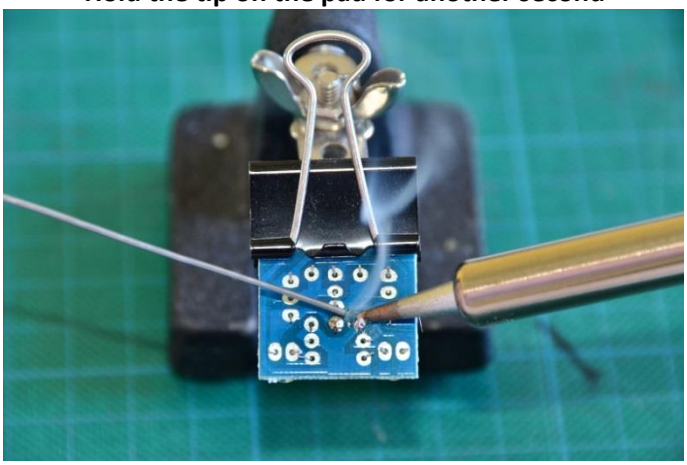
Apply just enough solder to cover the pad in 1 second



Hold the tip on the pad for another second

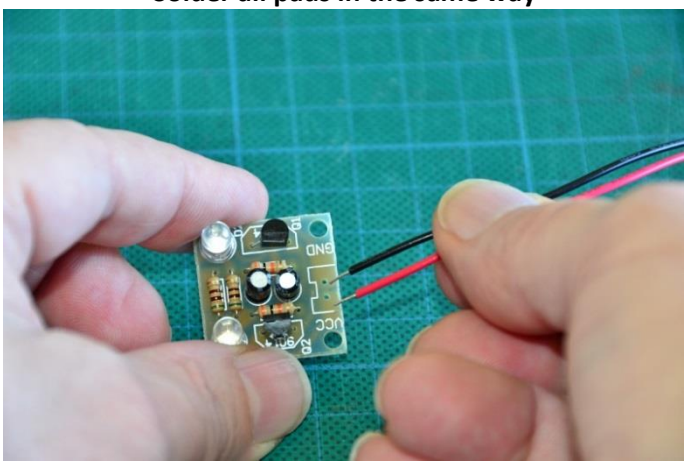


Remove the tip from the PCB

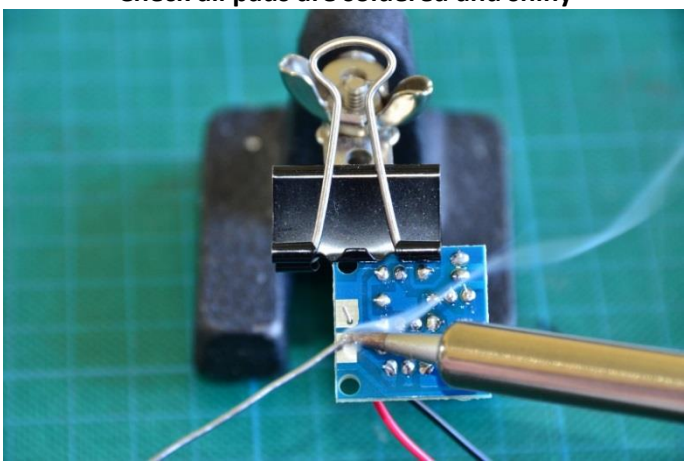


Solder all pads in the same way

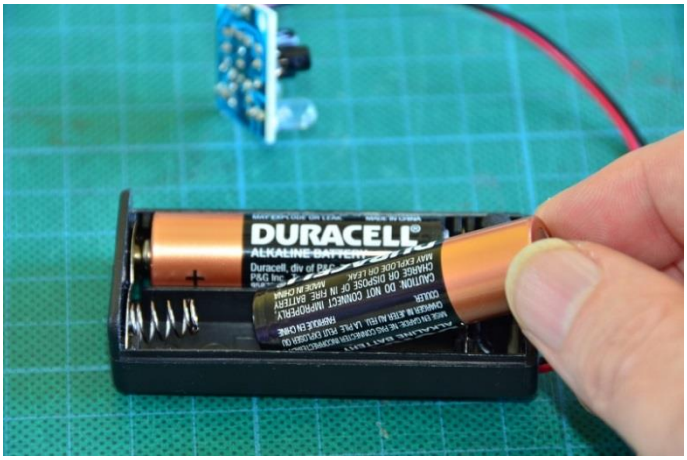
Check all pads are soldered and shiny



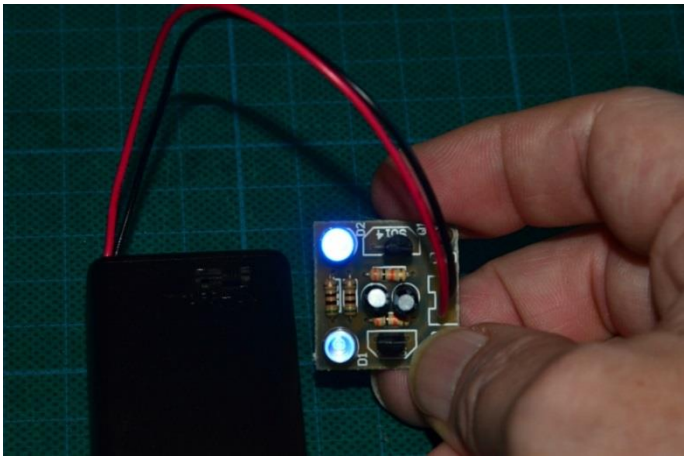
Insert the battery wires in the PCB. Red-VCC, Black-GND



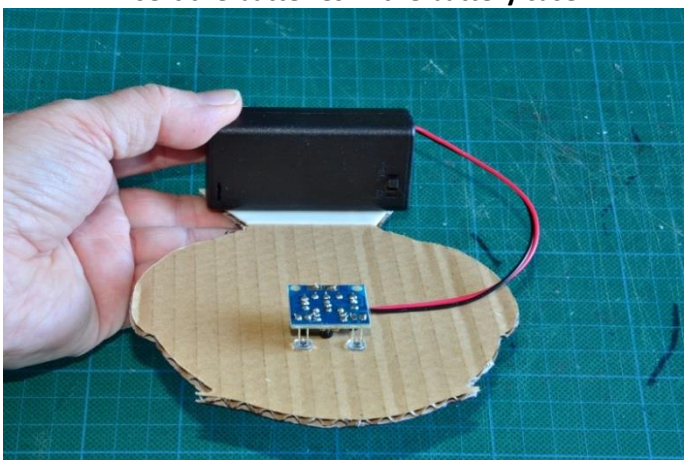
Bend and solder the battery wires



Insert the batteries in the battery case

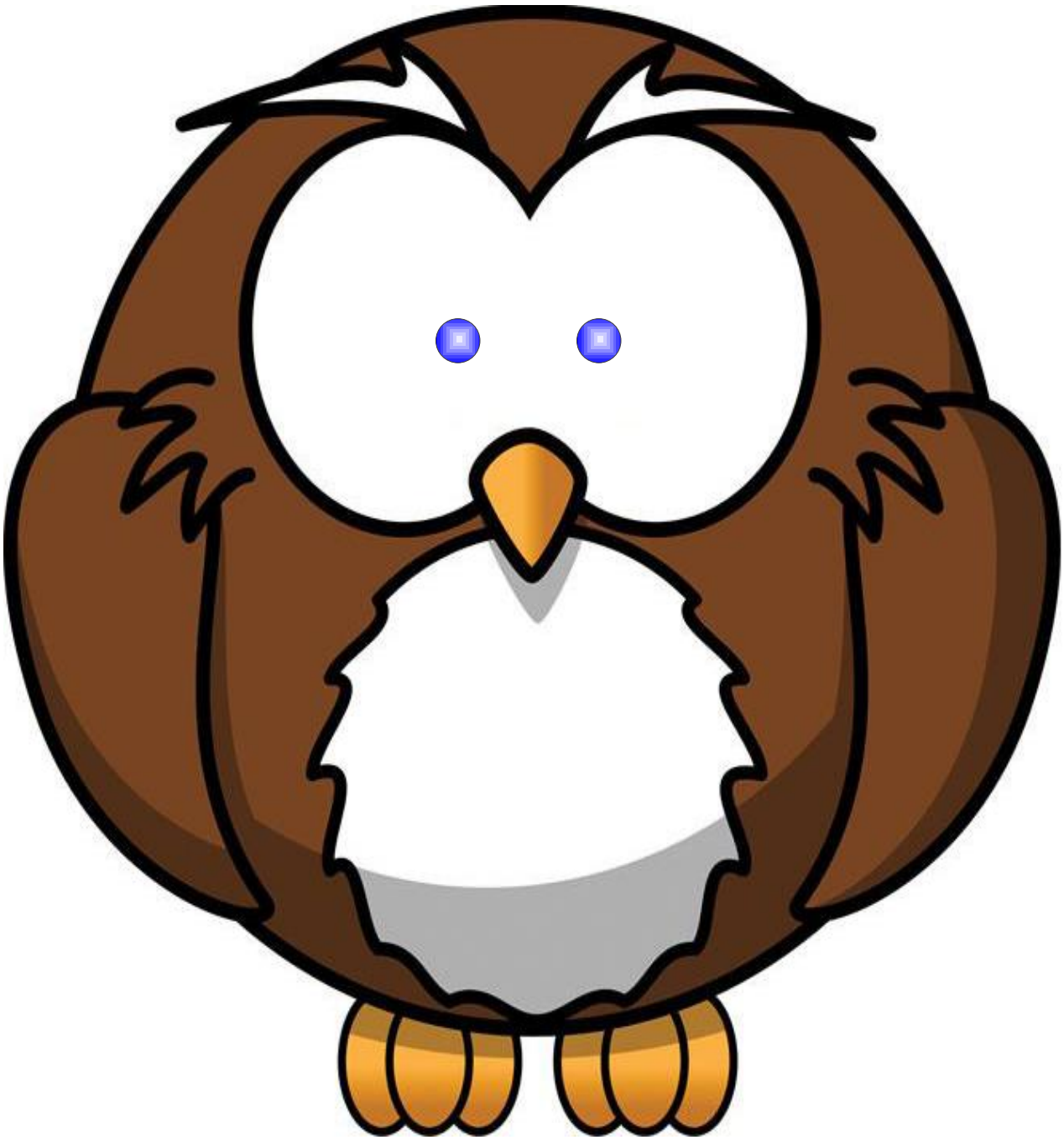


Turn on the switch and check the LEDs flash



Push the LEDs through the eyeholes of the model

Turn on the switch to be instantly hypnotised ☺



Cut out this picture of the hypnotic owl. Past it onto some thick cardboard. Poke round holes for the eyes using a skewer from the front. Make the eye holes no larger than 4mm, so that the LEDs will be a tight fit. Press the LEDs of the completed PCB through the eyeholes from the back. Mount the battery case on the base using double-sided tape.