PROJECT SHEET - NERVE TESTER GAME

CONTENTS:

DESCRIPTION

The *NERVE TESTER* is a simple game for students to make and assemble that uses a simple electronic (Protoboard) circuit.

The aim of the game is for the student to avoid touching the wire with the hand held loop. Touching the wire with the loop will result in the buzzer sounding and the LED lighting up.

The game makes use of the fact that electricity will only flow around a complete circuit - it will stop flowing the moment the circuit is broken. The idea is to try not to complete a circuit, so that a buzzer does not make a sound or an LED does not light up.

The game / competition can be made easier or harder depending on the group playing the game. For example:

- The handle loop diameter can be made smaller or larger
- The wire can be bent into an easier or more complicated shape
- The length of the wire to the handle can be shorter or longer, as another way to adjust the level of difficulty for playing the game

The illustration shows the prototype. Students are encouraged to design their own structure using the guidelines.

SECTION 1: COMPONENTS & MATERIAL REQUIRED

1.1 COMPONENTS REQUIRED

The following components are required and are available from Scorpio Technology (item codes in brackets). Before starting we suggest that you check you have all the components using the checklist below – tick off each component as you identify it.

☐ 1 x Battery Holder with switch – 9V	(BH9VF)
OR	
☐ 1 x Battery clip	(BCLIP)
☐ 1 x Toggle switch (on-off)	(SW1W)
☐ 1 x Mini Buzzer	(BUZZERMIN5)
☐ 1 x Protoboard	(PCB-PROTO)
☐ 1 x LED Red Diffused Lens 5mm	(LEDDLR5)
☐ 1 x Resistor 1K Ohm	(RES1K)
☐ 1 x Resistor 1.5K Ohm	(RES1.5K)
☐ 1 x Electrolytic Capacitor 100uF	(CAP100UF)
☐ 1 x Transistor S9011	(TRAN9011)

☐ 1 x Black Heatshrink – 3mm x 40mm	(SHRINK3BLK)
☐ 1 x Grey Guide Tube 100mm	(GUIDG)
☐ 2 x Brass Washers M3	(WASHBRM3A)
☐ 1 x Copper Wire – 2mm x 600mm	(WIRECOP2/14)
☐ Hot glue or double-sided foam tape	(GLUESTK / TAPEDS)
☐ 1 x 9V battery	(BATT9)
☐ Multi strand hookup wire (red and black)	(WIREHU10BK & WIREHU10R)

1.2 ADDITIONAL REQUIREMENTS

The following material is to be supplied by the student / designer:

☐ All the material for the base and side supports
☐ 15-20mm nails for fixing the side supports to the base.
☐ 15-20mm dowel or metal rod (for forming the loop in the handle's copper wire)

1.3 TOOLS REQUIRED

The following tools are required. A number of these are available from Scorpio Technology, and can be ordered separately if required (item codes in brackets):

☐ Soldering Iron: a good quality soldering iron, with a fine tip (SOLDIRN) and Soldering Iron Stand (SOLDIRNSTD) or Soldering Station (SOLDSTN)
☐ Solder: the use of 0.71mm 60/40 solder is recommended (SOLD250/SOLD500)
☐ Wire strippers (WIRESTR)
☐ Side cutters (SIDECUT or SIDECUTM)
☐ Pliers (PLIERBN) or Mini bolt cutter (BOLTCUTMIN)
☐ Hot glue gun (GLUEGUN) and hot glue (GLUESTK)
NOTE: At various stages of construction, items may need to be glued together. We have found hot glue guns give good results.
☐ Assorted hand tools – depending on the choice of materials to be used
☐ Drill
☐ 2mm drill bit (for the copper wire)
☐ 5mm drill bit (for the LED)
☐ Ruler and pen
☐ Craft knife (CRKNF)

1.4 ADDITIONAL RECOMMENDED EQUIPMENT

Heat gun or hairdryer

- This is needed to shrink on the heatshrink tubing on the ends of the wire loop.
- If using a hot glue gun it is useful to have a hair dryer or heat gun available during construction work. Using the hair dryer on its hottest setting will allow students to heat up the hot glue to soften it and will allow students to reposition or remove incorrectly positioned or faulty components.

SECTION 2: GENERAL AND PLANNING INFORMATION

DESIGN CONSIDERATIONS

2.1 GENERAL

The photo in the DESCRIPTION shows the prototype made. Students are encouraged to design their own shape using the guidelines and information provided.

Before starting construction, the student needs to carefully plan and layout all of the components - the picture at the end of the document can be used as a guide.

2.2 ITEMS FOR INVESTIGATION

This project provides a number of different aspects for investigation of the *NERVE TESTER GAME*. Some ideas are listed below.

BASIC

- After construction, students can compete against each other to see which student in the class / group completes the course the fastest, without their loop touching the wire.
- Evaluate the suitability of various materials for the platform, such as PVC, acrylic, plywood or balsa wood.

MORE CHALLENGING

- Research and explain how a Buzzer works?
- How does a battery produce electrical energy?
- What sort of energy transformation takes place within a battery?
- Describe how a 9 volt battery is constructed so it produces 9 volts?
- How does a LED work? How is its operation different to an incandescent globe?
- Students can investigate why a resistor is necessary in series with the LED. What is its function?
- What is the purpose of the capacitor?

SECTION 3: DESIGN BRIEF AND DESIGN

3.1 DESIGN BRIEF

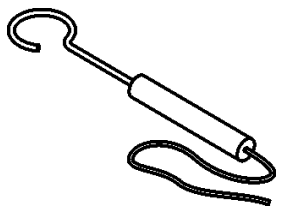
1. To design a structure that can test the steadiness of students' hands.
2. To determine which material is suitable for the construction of the tester platform / baseboard.
3. To construct a structure with the correct wiring and component positioning.
4. To construct a structure that is visually tidy and appealing.

Additionally, this is a good time to work out the format and rules of the competition – there are some ideas at the end of this unit.

3.2 DESIGNING THE PARTS OF THE *NERVE TESTER GAME*

THE HANDLE AND LOOP

This kit contains a 100mm length of plastic tube, which can be used for the handle. Its outer diameter is 5mm – the designer may choose to use larger tubing or dowel for a better grip.

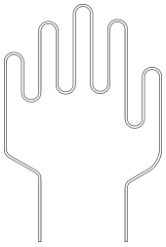


If dowelling is to be used, this should be drilled from the loop side with a 2mm drill, and a larger drill most of the way from the other end (the drill size could depend on the dowel's outer diameter).

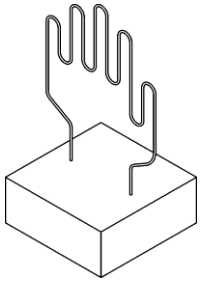
THE BENT WIRE (LOOP)

- ☐ This is made using the 2mm diameter copper wire – there should be about 50cm left after cutting off the length for the handle and loop.
- ☐ The 2mm copper wire can be bent to any shape you like, either in 2D or 3D. For example, you could make a map of Australia, trace your own hand, or make something that has depth – just so long as it can followed with the hand held loop.

SUGGESTION: Before starting to bend the copper wire, it is best to measure the length of the drawn shape with a piece of string, to determine if 50cm is sufficient for the design. If not, it should be scaled down, or a new or simpler design drawn.
NOTE: The more complex the shape (such as a hand) the more wire is required.



Your hand …



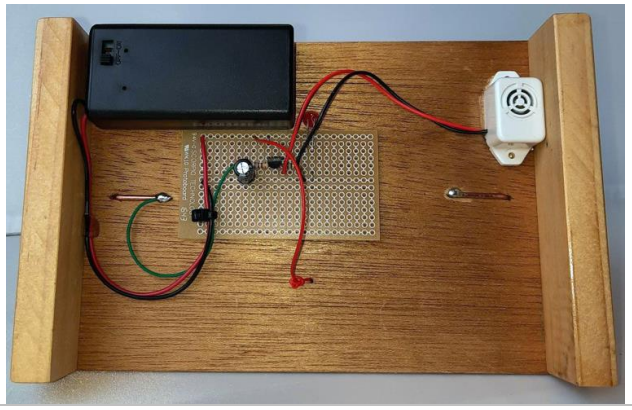
… mounted on a base

Remember to allow extra length on both ends to go through the baseboard and be bent over on the other side (about 15-20mm).

THE BASE

The student needs to determine the material from which the platform / base is to be constructed. It can be made from a variety of materials, depending on what materials are available, such as plywood, timber or acrylic. It also can take into account the manufacturing technology at school, such as 3D printing, laser cutting or milling.

The platform can be made from any size piece of material. However, the aim is to store the components beneath the platform / baseboard.

When designing the size and shape of the base, a number of factors need to be taken into account: - Before deciding on the size of the base, the designer needs to design the size and shape of the bent wire, as that will affect the base's minimum size. - Determining the positions for all the components, including the battery holder / switch and buzzer.	One suggestion for a simple base layout shown from underneath: 

- Placement of the LED on the platform / base board and how it will be soldered to other components / wires.

NOTE: The holes sizes required for the components are:

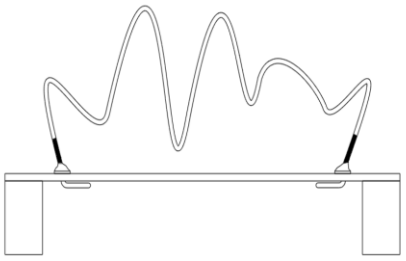
☐ 5mm for the LED
☐ 7mm for the toggle switch (if selected)
☐ 2mm for the bent wire loop
☐ The 2mm hole for the handle wire is the size used for the prototype. The size of this hole will depend on the size of the hookup wire used.

There are 3 options for making the base if using timbers or plywood, with the simplest approach being to use plywood with everything mounted on top, with side supports underneath.

To make the design more aesthetically pleasing, the designer can make the base so that the components can be mounted underneath, with only the wire handle visible above. This can be done either by:

- Making a box or enclosure
- Taking a thick board and router out the underneath (this will be time consuming and dependant on student skill).

NOTE: If making a box you can have sides all around or a strip on either end. It is up to you to design your project and this is one aspect you will have to consider. In the picture only two end strips have been shown for clarity. The height of the end strips has to be enough to fit both the battery and buzzer.



NOTE: If using solid timber, the bent copper wire will need to be inserted through the thick section (not the hollowed out part). You will also need to recess the LED hole underneath to allow it to protrude through to the other side.

THE ELECTRONICS

The electronic components will be soldered as in Section 5: Assembling the Electronics. A location and attaching / mounting method need to be worked out at the baseboard design stage.

SECTION 4: MAKING THE PARTS

WARNING: If using hot glue, be very careful, because if you get it on yourself, it will burn you.

4.1 MAKING THE BASE

If making a box type enclosure, cut out the parts but do not assemble them yet – that will be done after drilling the holes for the loop, LED and handle in the top.

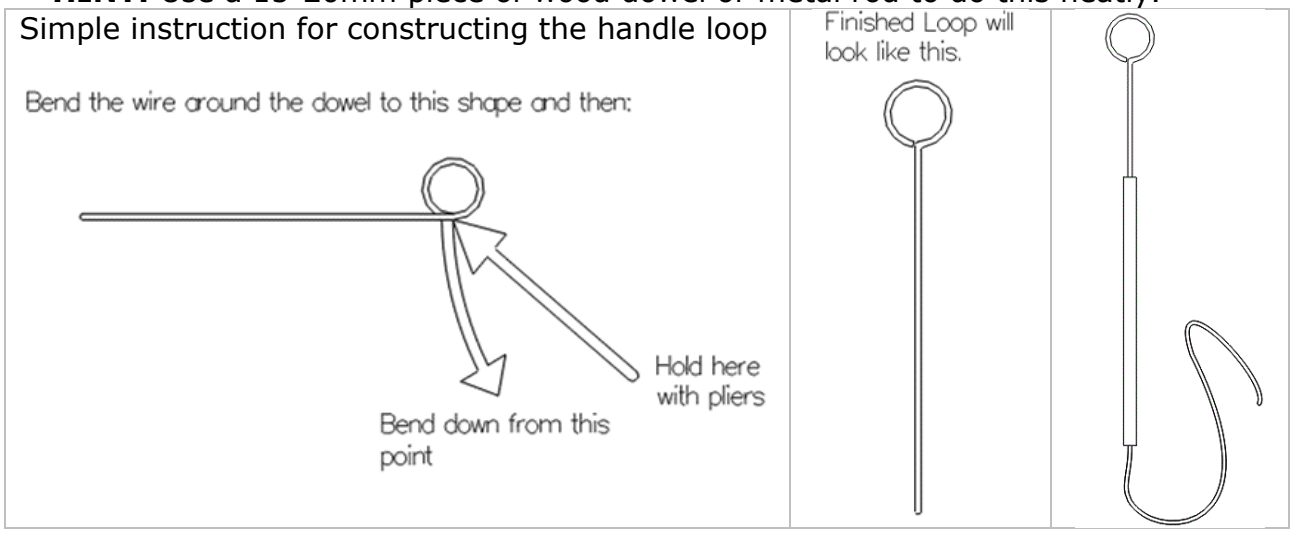
- ☐ Mark out and drill all the holes for the bent wire loop, LED and handle.
- ☐ Fix the side supports to the top. If you are using wood, you can use the small nails to join them together. A small amount of wood glue will enable a stronger join.

4.2 MAKING THE HANDLE AND LOOP

To make the handle:

- ☐ Cut a 100mm length of guide tube – the GUIDG is a 500mm long piece.
- ☐ Cut approximately 10cm length off the 2mm x 600 mm copper wire.
- ☐ Bend one end of the short length of copper wire to form a circle, with an outer diameter (O.D.) of approximately 15-20mm (a smaller diameter makes it more difficult).

  HINT: Use a 15-20mm piece of wood dowel or metal rod to do this neatly.



- ☐ Feed the red hookup wire through the guide tube (the handle) until a small amount appears through the far end.

☐ Add hot glue to the top (loop) end of the guide tube to prevent the loop from pulling out or twisting around.

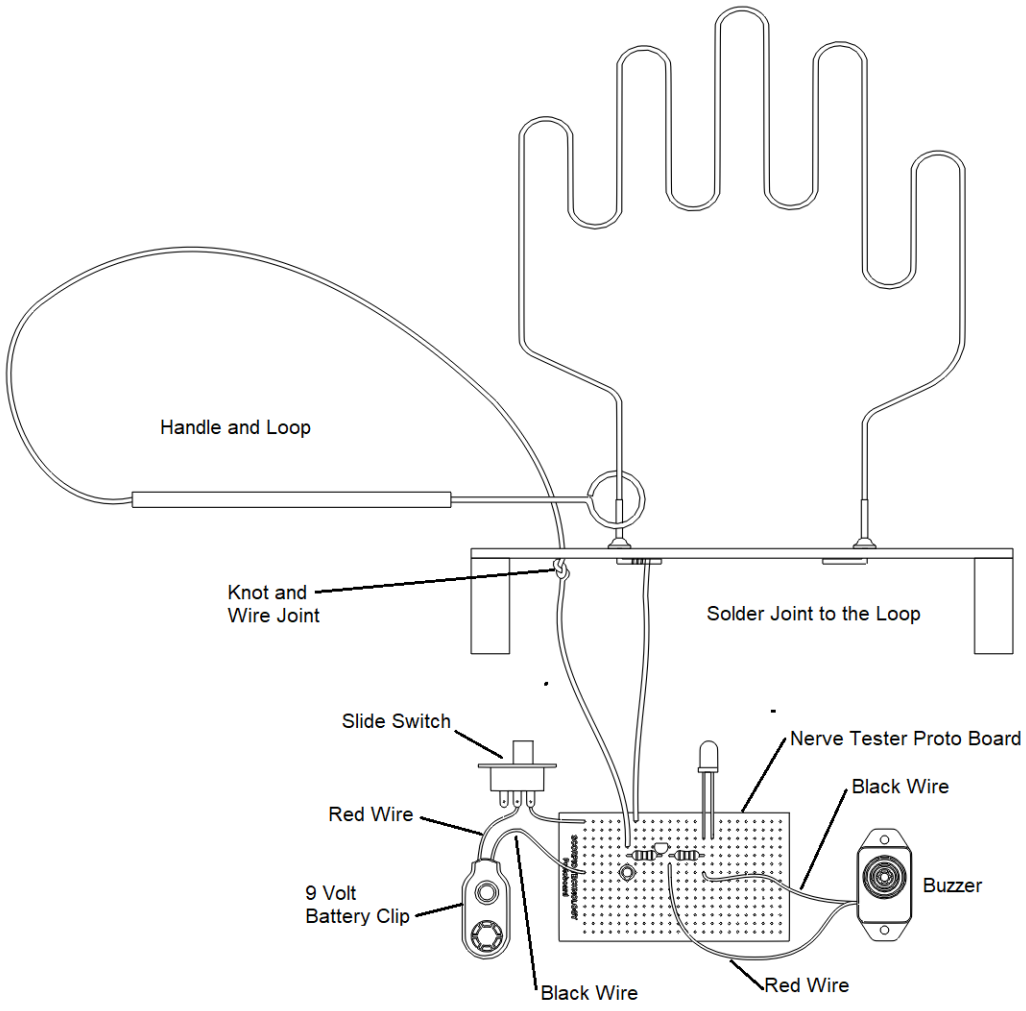
4.3 MAKING THE BENT WIRE

☐ Using the 2mm copper wire, bend it to your designed shape.
☐ Strip back the end of the red hookup wire, twist it around the straight end of the looped copper wire and solder in place.
☐ Gently pull the red hookup wire back through the guide tube gradually until only approximately 3-4cm of the looped copper wire with the looped head is visible.

SECTION 5: ASSEMBLING THE ELECTRONICS

5.1 WIRING UP THE HANDLE

☐ Cut the handle's red hookup wire so that at least 30cm of wire hangs out the other end of the handle.
☐ Feed the red wire through the hole in the base top plate. Tie a loose knot in the wire underneath the base top plate. Do not tighten the wire yet.
☐ Strip back the end of the red hookup wire and solder it to the wire identified as Loop on the Protoboard, as shown in the picture in Section 5.3.
☐ Slide the knot down so it is over the wire join and tighten the knot. This will stop the wire being pulled up through the hole. Pull the knot up to the hole and use some hot glue to hold it to the base.



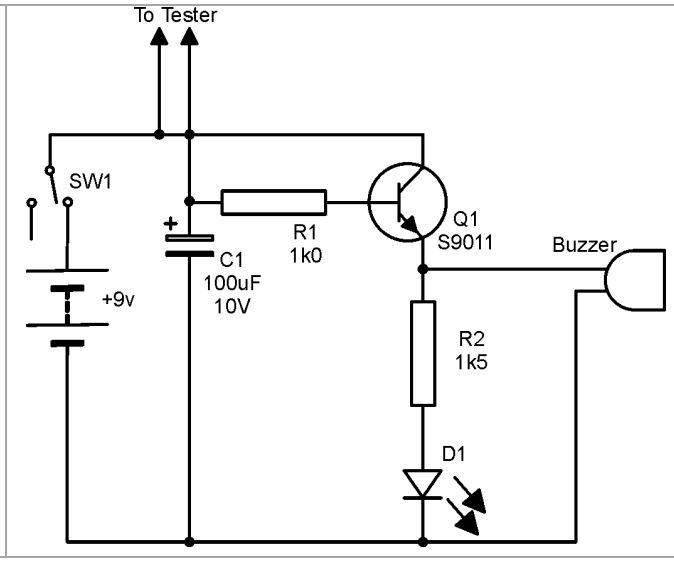
5.2 ASSEMBLING THE *NERVE TESTER* ELECTRONICS

The various components used in this project are mounted and then soldered onto a Protoboard.

- The circuit diagram shows the various connections between the components.

The base, wire loop and handle are to be designed and constructed by the student and the completed Protoboard PCB is to be mounted underneath the base and connected to the wire loop and handle.

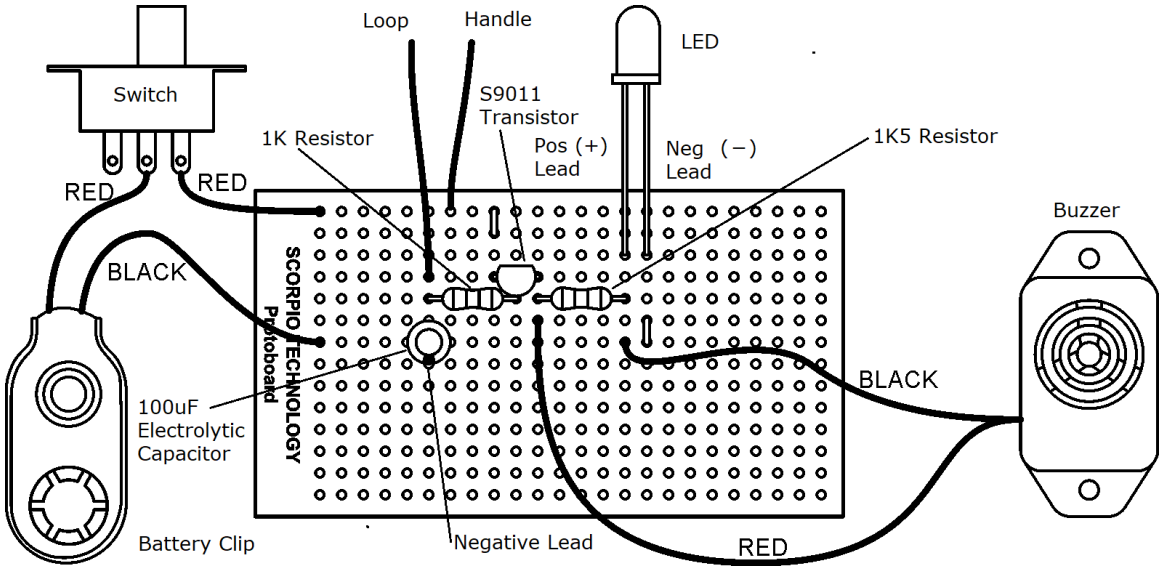
CIRCUIT DIAGRAM



5.3 ASSEMBLY OF THE PROTOBOARD

The picture below shows the position of the components mounted on the top (brown side) of the Protoboard and the wires connected to the switch, battery clip and buzzer.

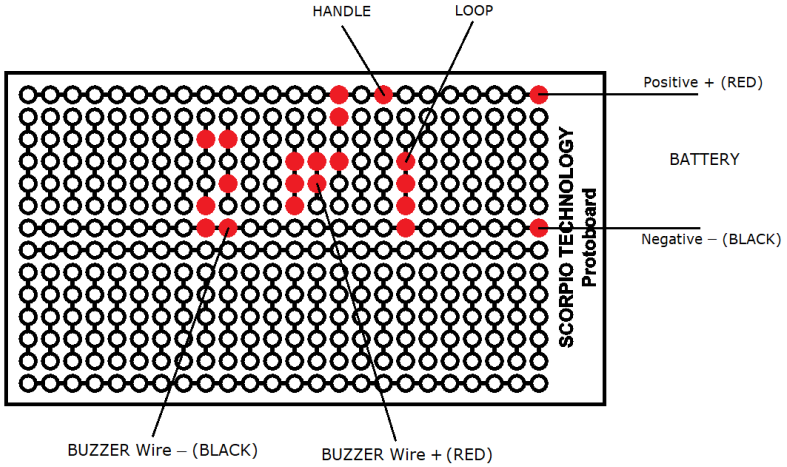
NOTE: This diagram shows the battery clip and switch separately – if you have chosen to get the battery holder with switch, the battery holder's red wire is soldered directly to the Protoboard.



- ☐ To mount the components accurately count the number of holes shown on the diagram and insert the components in place.
  - Refer to the picture showing the solder connections below.
- ☐ Solder the components in place.
- ☐ The wire going to the bent wire loop is identified as Loop.

- ☐ The wire going to the handle is identified as Handle.
  - Make sure that you have a much longer wire (at least 300mm) for connection to the handle to allow it to be easy to move along the wire loop.

These are the soldering connections as seen from the solder side (underneath – green side) of the Protoboard:



☐ Once assembled as shown in the picture, connect the battery, turn on the switch and touch the bare ends of the loop and handle wires together to see if it works.
NOTE: It is better to find out if the Protoboard works properly before assembly - it is much easier to fix anything without wires connecting it to the base.

☐ When the wires are touched together both the LED and the buzzer will operate for a short time. If it does not operate as expected go to the section on fault finding, to see where the problem may be.

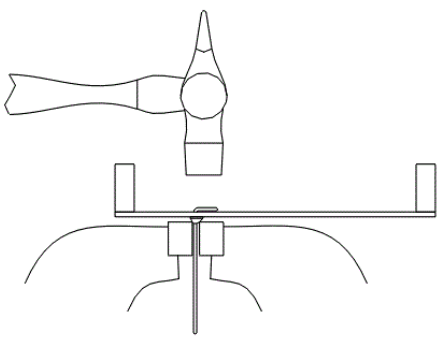
SECTION 6: ASSEMBLING THE *NERVE TESTER GAME*

☐ Cut the heatshrink in half and slide the two pieces of heatshrink onto each end of the 2mm copper wire. Slide them up away (70-80mm) from the ends, so that they don't shrink onto the wire when soldering the washers in place.
☐ Slide a washer onto either end of the copper wire.
☐ Insert the ends of the bent wire into the two holes you drilled in the base for the wire loop, so the ends protrude about 15mm underneath. Make sure the washer is sitting flat on the base.
☐ You are going to solder the washer and wire together:
- Tin the soldering iron tip so you have a decent blob of solder on the tip.
- Place the soldering iron tip so that it is sitting on the washer and is pressed up against the wire. Do not take the soldering iron away until you have finished soldering. This will heat up both the washer and the wire at the same time.
- Apply solder to both the washer and wire. You must melt solder onto the hot washer and wire, apply plenty of solder until there is solder all the way around the washer and wire. It should look a bit like a volcano with wire coming out the top.

NOTE: If using plastic for the base, take care to do this quickly, or possibly using a scrap piece of timber, or you may melt and damage the plastic.

☐ Open a metal working vice just wide enough to allow the wire to fit. Rest the soldered washer on the jaws of the vice as shown and use a hammer to bend over the end of the wire firmly onto the base. Bend over both ends of the wire.

WARNING: If you are using acrylic plastic for this, take extreme care as hitting the wire too hard could shatter the plastic.



- ☐ Slide the heatshrink tubing down against the washers.
- ☐ Use a heat gun (or hair dryer) to heat up the heatshrink tubing.
- ☐ When heated, the tubing will shrink onto the wire and stay firmly fixed to the wire.
- ☐ The heatshrink tubing forms a barrier preventing the loop of the wire handle from touching the wire.

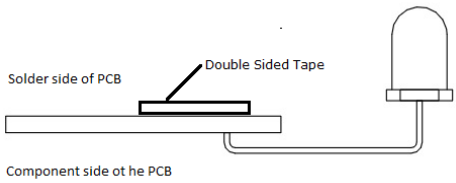
ASSEMBLING THE ELECTRICAL COMPONENTS

- ☐ Place the ring at the end of the handle around the wire loop and squeeze the end of the ring in so that cannot be removed from the loop.
- ☐ Mount the buzzer - you can either use small screws to fix the buzzer or you can use hot glue.
- ☐ Attach the battery / battery holder to the base:
    - If you chosen to use the battery holder and switch, you can use hot glue to fix the battery holder to the base or side support.
    - If you've chosen to use a battery clip, attach some double-sided tape to the battery and fix it to the base or side support.
- ☐ If using a separate switch, mount that now by removing the nut and washer, inserting the switch from underneath and tightening the nut and washer on top.

NOTES:

- ☐ If supplied in the battery holder, ensure that the small fixing screw on the bottom of the battery holder is removed. If this is not done, when the battery holder is glued down you will not be able to open the battery holder to insert a battery.
- ☐ Do NOT glue down the side of the battery holder with the switch.

- ☐ To fix the PCB in place bend the LED as shown and then push the LED into the 5mm hole previously drilled for the LED.
    - Use either double-sided tape on the soldered side of the PCB or hot glue
    - Press the PCB firmly up against the plywood base



NOTE: Only use the hot glue method if you have tested your project and everything is working as it should.

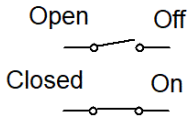
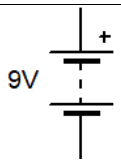
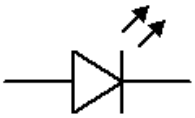
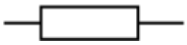
TESTING THE CIRCUIT

- ☐ Insert the battery into the battery holder
- ☐ Turn on the battery holder's switch. Touch the handle to the loop, both the LED and the buzzer should operate. If not proceed to Section 9: Fault Finding

SECTION 7: KEY WORDS AND COMPONENTS

Circuit Diagram: A graphical representation or plan of an electrical circuit. It shows the different elements of an electrical circuit and how they are interconnected to each other through the use of specific symbols.

COMPONENT	SYMBOL	PURPOSE	EXAMPLE
Buzzer		A buzzer converts electrical energy into sound.	

Switch		A switch is used to open or close a circuit	
Battery		A battery is a device that stores chemical energy and converts it to electrical energy.	
LED		LEDs (Light Emitting Diodes) convert electrical energy directly into light	
Resistor		The main function of a resistor is to limit current flow to the desired value when used in a circuit.	

SECTION 8: THEORY

The game is designed to test hand to eye coordination skills. The Nerve Tester game involves trying to get a hand held loop from one side of a bent wire to the other, without the two touching.

Electric current is the flow of electrons through a circuit, and the electricity can only flow if a circuit is continuous - the game works because it is made from an incomplete electrical circuit.

- The object of the game is to NOT close the circuit.

WHY DOES THE BUZZER SOUND AND THE LED LIGHT UP?
When the hand-held loop touches a section of the bent wire loop, the circuit is completed (closed) which allows electricity (current) to flow from the batteries, through the loop and the bent wire, to the Protoboard circuit. This causes the buzzer to sound and the LED to light up. They come on and stay on for a period of time, and only stop working when the capacitor has discharged.

- The moment the copper loop and bent wire touch, the circuit is complete and the buzzer and LED announce that to everyone!
- The buzzer converts electrical energy into sound energy and the LED converts electrical energy to light energy.

SECTION 9: FAULT FINDING

What to do if your *NERVE TESTER* project doesn't work properly – that is, if the LED does not light and/or the Buzzer does not work.

- ☐ Check battery voltage. It should be around 9 Volts.
- ☐ Check that the LED is facing in the correct direction.
- ☐ Check that Transistor Q1 is facing in the correct direction.
- ☐ Check that the leads from the LED are not short circuited by a solder bridge on the PCB.
- ☐ Check the values of resistor R1 and R2.

- ☐ Check the value of C1. Check that C1 has its positive and negative leads in the correct direction. If the capacitor is inserted the wrong way round the circuit will not work.
- ☐ Check for short circuits (solder bridges). Check that solder joints are not "frosty" – possible dry joint.
- ☐ Check the orientation of the battery leads connected to the PCB. Red is positive and black is negative.
- ☐ The LED operates but the buzzer does not work.
- ☐ Check the orientation of the buzzer leads connected to the PCB. Red is positive and black is negative.
- ☐ Check the position of components on the PCB against the drawing. Even one hole position different will probably mean it is a problem.
- ☐ Check for short circuits (solder bridges) these can occur more easily between soldered leads that are close together, so carefully check around T1. Check that solder joints are not "frosty" – possible dry joint.
- ☐ Compare your project to a working one and look for differences in component placing, orientation, component values and soldering.

SECTION 10: RULES OF THE GAME

The aim of the game is for the student to guide the loop all the way around the bent wire without touching the loop against the wire. If the metal loop touches the bent wire, the buzzer will sound and the LED Light up.

You can develop your own rules for the game, or how to make it into a competition. There are different ideas for how to run this.

THE INDIVIDUAL'S PERSONAL BEST:

If the metal loop touches the bent wire, when the buzzer sounds, the player must start again. The player tries again, until they reach the end and record their time. This can be repeated to see if the player can improve on that time.

CLASS COMPETITION - TIMED:

If the metal loop touches the bent wire, when the buzzer sounds, the player must start again. The winner will be the player who reaches the end of the wire in the quickest time.

CLASS COMPETITION – KNOCK OUT:

If the metal loop touches the bent wire, when the buzzer sounds, the player is out. If the player gets to the end, without the buzzer sounding, the player remains in. Then the next player has a try, and either remains in or goes out.

This continues until all have had a go. Then, those who are still in repeat the game. This continues until only one person is left in.

ARE YOU AMBIDEXTROUS?

Once you've mastered this game, swap hands and test your skill with your other hand.