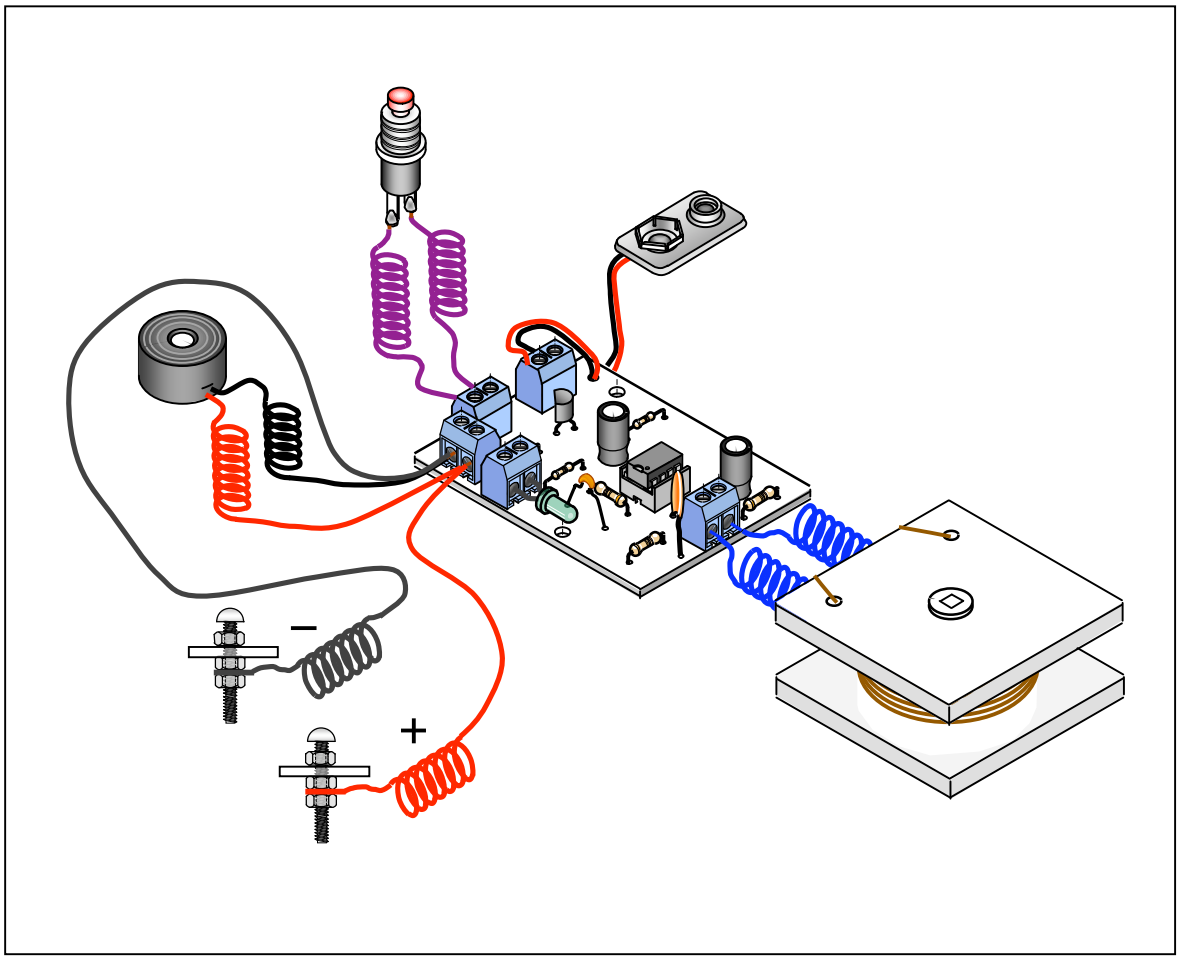
centre de développement pédagogique
*pour la formation générale en science et technologie*

Working document

# "GAUSSBUSTERS" LES
# GAUSSMETER TECHNICAL FILE




**MAY 2011**

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# FABRICATION RANGE

ELEMENT: **Printed circuit plate**

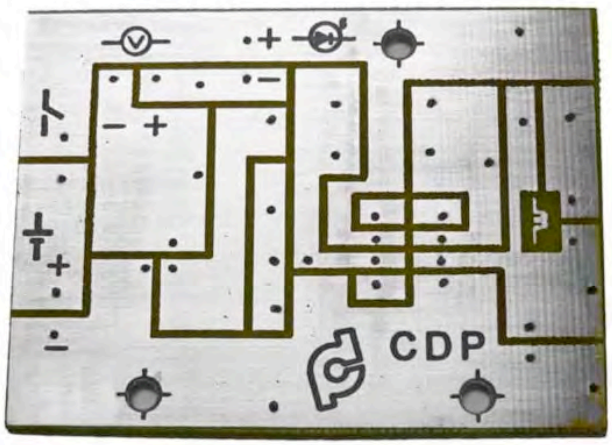
SET: **THE GAUSSMETER**

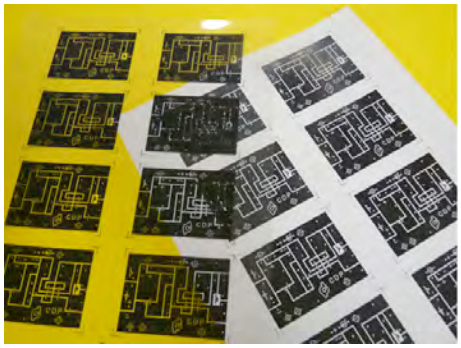
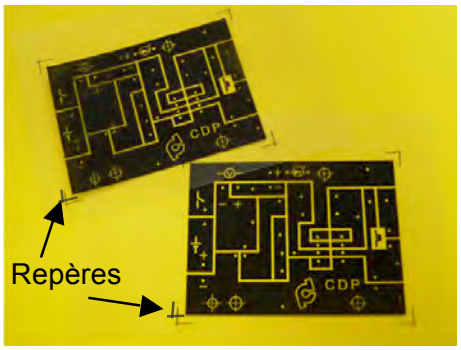
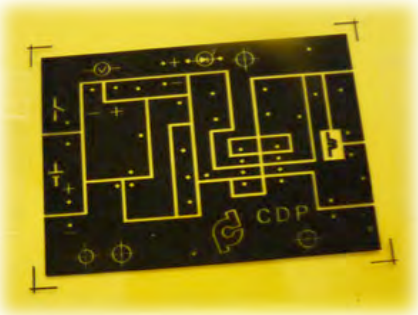
RANGE: **1**

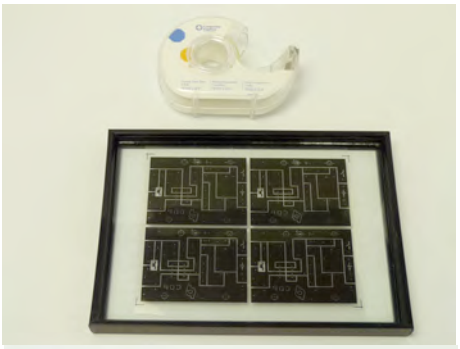
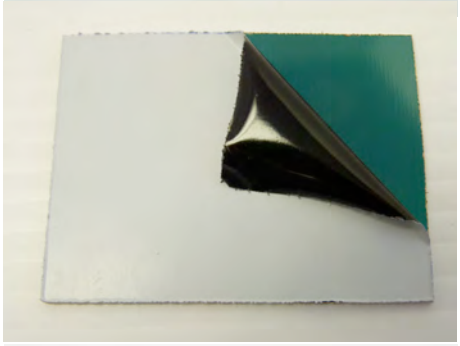
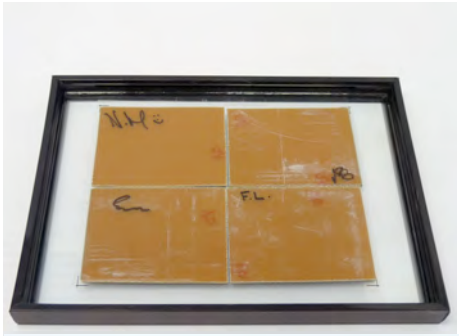
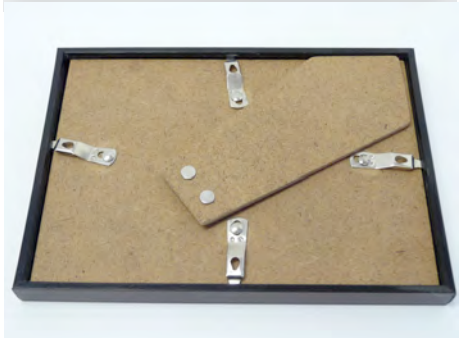
SHEET: **1 of 6**

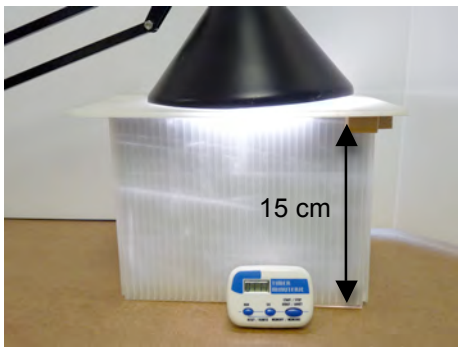
NUMBER: **1**

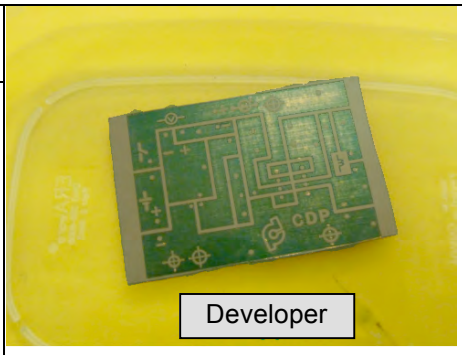
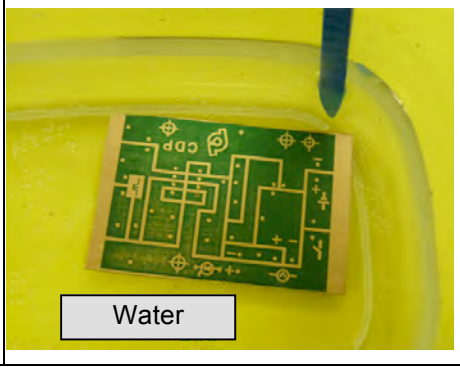
MATERIALS: **Various**

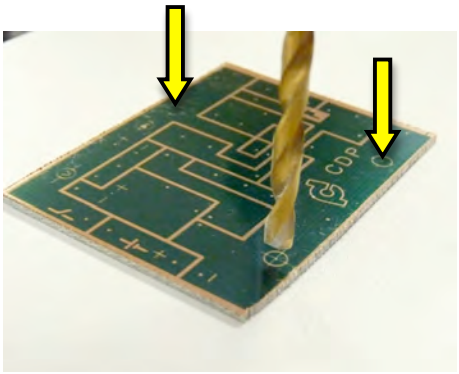


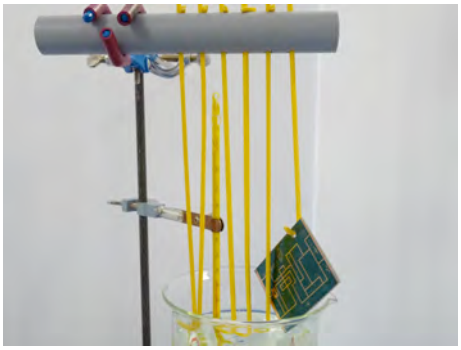
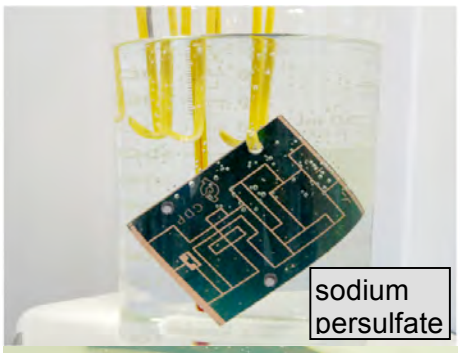
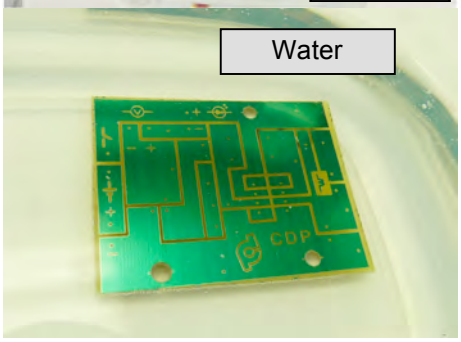

| N° | PHASE, SUB-PHASE OR OPERATION | PHOTO OR DRAWING | MACHINE-TOOL, TOOLS |
|---|---|---|---|
| **10** | **PRINTING THE MASK** | | |
| 11 | Print the mask for the circuit (image). |  | – Printer |
| 12 | Using this copy, print a transparency (acetate). | | – Transparency (acetate)<br>– Photocopier |
| 13 | Cut two masks of the circuit and superimpose them. The corner bearings will allow you to line up the two pieces correctly. The CDP logo and letters can also be used as bearings.<br><br>Glue the two masks together using adhesive tape. |  | – Scissors<br>– Adhesive tape |
| | **Important:** Superimposition allows the mask to be sufficiently opaque. |  | |

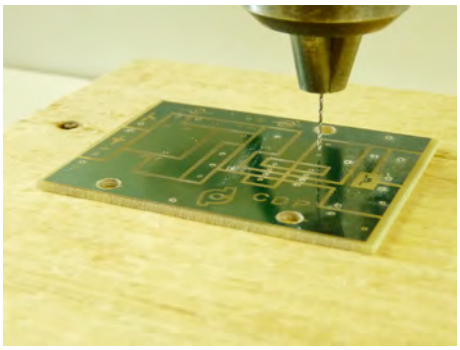
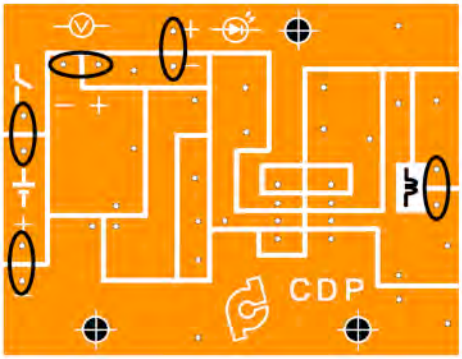
| | | | |
|---|---|---|---|
| **20** | **RESIN EXPOSURE** |  | |
| 21 | Place the mask in a picture frame. Affix it using adhesive tape. (Here the 4 masks appear in the frame).<br>**Note**: The CDP logo must be right side up once the frame is turned over. | | – Frame<br>– Adhesive tape |
| 22 | Identify your photosensitive resin plate on the (beige) insulated side. |  | – Photosensitive resin plate<br>– Permanent marker |
| 23 | Remove the protective film from the photosensitive resin plate.<br><br>**Careful:** It is very easy to scratch the plate's photosensitive resin. |  | – Photosensitive resin plate |
| 24 | Place the plate on the acetate (4 plates are shown in the frame). The green coloured photosensitive resin must be face down (i.e. on the transparency). |  | – Frame<br>– Affixed mask |
| 25 | Close the frame and turn it right side up.<br><br>**Important**: The CDP logo must be right side up once the frame is closed and turned over. |  | |

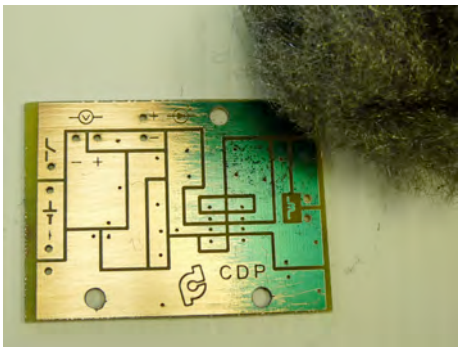
| | | | |
|---|---|---|---|
| 26 | Expose* the plate **8 to 10 minutes** under a lamp with an ultra violet bulb.<br><br>* Expose: Subject to light. |  | – Desk lamp<br>– UV or ordinary compact fluorescent bulb<br>– Timer |
| | The use of a reflector allows you to move the light further away and produces a more uniform, precise exposure. The reflector is made from a Coroplast box adapted to the size of the frame and whose interior is lined with a reflective substance (aluminium foil or Mylar). |  | – Reflector<br>– Desk lamp<br>– UV or ordinary compact fluorescent bulb<br>– Timer |
| 27 | Withdraw the exposed plate from the frame. | | |

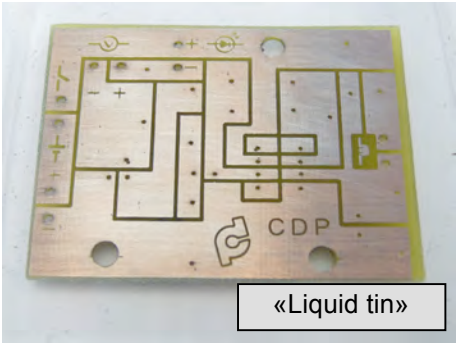
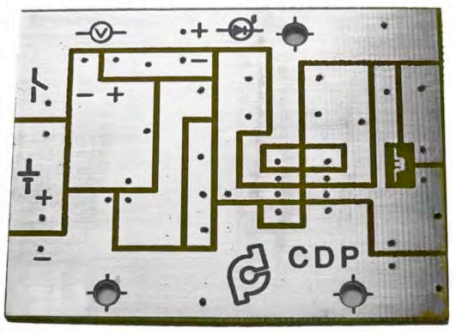
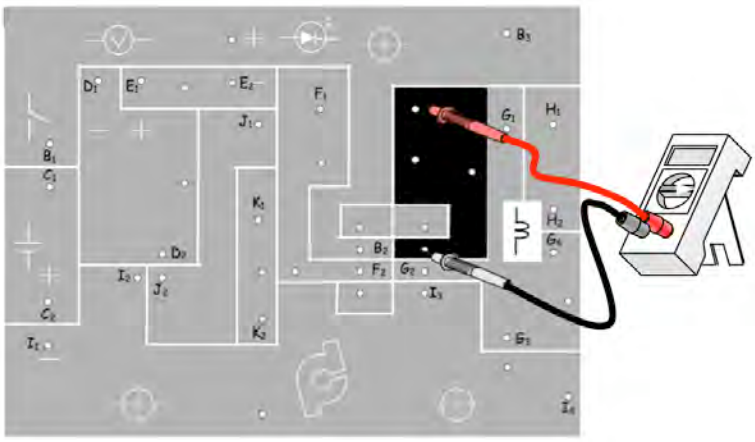
| | | | |
|---|---|---|---|
| **30** | **DEVELOPING THE PLATE** | | |
| 31 | Place the plate in the "Developer" solution. **(Resin side up)**<br><br>Shake the plate until it is completely developed (i.e. until the pattern appears completely copper covered).<br><br>This takes about **10 seconds.** |  | – Safety glasses<br>– Bath containing developer solution (NaOH)<br>– Plastic tweezers |
| 32 | Rinse in "developer" water bath.<br><br>Carefully sponge without scratching the resin.<br><br>**Careful!** At this stage, the resin is fragile and the plates need to be handled with care. Any scratches may cause a defect in the circuit. |  | – Safety glasses<br>– Water bath<br>– Plastic tweezers |

| | | | |
|---|---|---|---|
| **40** | **DRILLING (to affix the plate)** |  | – Safety glasses<br>– Punch<br>– 5/32 in Ø bit.<br>– Press drill<br>– Drill vice<br>– Martyr |
| 41 | Punch and drill the three plate fixation holes to a diameter of 4 mm (5/32 in.). One of these holes will be used to hang the plate during the next step.<br><br>**Note :** The drill vise and martyr do not appear in the photos in order to make the operation more clear. | | |

| | | | |
|---|---|---|---|
| **50** | **ENGRAVING THE PLATE *** |  | – Laboratory hood<br>– Safety glasses<br>– 1000 mL beaker<br>– Hot plate with magnetic agitator<br>– Magnetic bar<br>– Thermometer with clamp<br>– Universal support<br>– Timer<br>– Plastic covered wire for holding plate |
| 51 | Suspend the plate in a sodium persulfate solution. Let it react until the copper that was exposed to the UVs is completely dissolved.<br><br>The solution must be at 40°C and must be stirred.<br><br>**Note:** When the copper borders are dissolved, the plate must be removed. This may take **10 to 15 minutes.**<br><br>*** IMPORTANT:** It is recommended to carry out this operation under the hood or to ensure the room is well ventilated. |  | |
| 52 | Rinse in the "sodium persulfate" water bath and wipe. |  | – Safety glasses<br>– Water bath<br>– Plastic tweezers<br>– Absorbent paper |

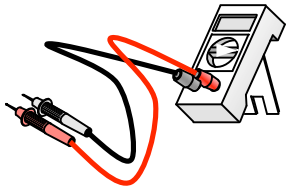
| | | | |
|---|---|---|---|
| **60** | **DRILLING (for the components)** | | |
| 61 | Slowly drill all the holes with a 1 mm (1/32 in.) diameter.<br>A press drill is necessary to avoid breaking the drill bit. For the same reason, the bit should not exceed the chuck by more than 10 to 15 mm.<br><br>**Note:** The drill vise does not appear in the photos in order to make the operation more clear. |  | – Safety glasses<br>– 1/32 in. Ø bit.<br>– Press drill<br>– Drill vise<br>– Martyr |
| 62 | Widen the connector holes to a diameter of 1.5 mm (1/16 in.)<br><br>**Note:** The holes corresponding to the connectors are circled in the diagram at right. |  | – Safety glasses<br>– 1/16 in. Ø bit.<br>– Press drill<br>– Drill vise<br>– Martyr |

| | | | |
|---|---|---|---|
| **70** | **BARING THE COPPER** | | |
| 71 | Using steel wool, remove the remaining photosensitive resin.<br><br>Rinse with water and **wipe well.**<br><br>**Important**: Handle the plate with a pair of tweezers or by the sides, since the oil from your fingers may prevent the tin from adhering at the next step. |  | – Safety glasses<br>– Steel wool<br>– Water bath<br>– Plastic tweezers<br>– Absorbent paper |

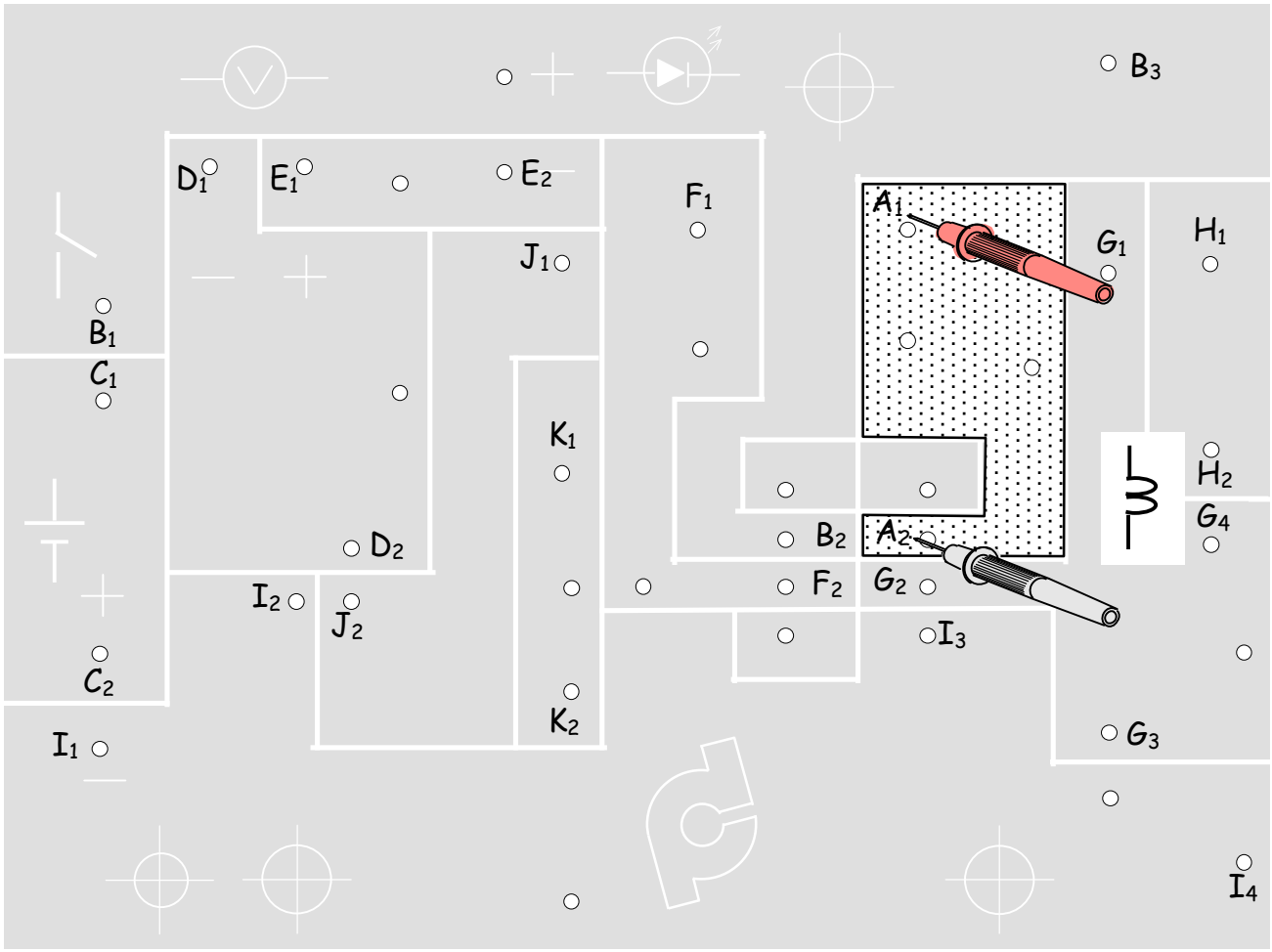
| | | | |
|---|---|---|---|
| **80** | **TINNING THE PLATE *** | | |
| 81 | Soak the plate **about one minute** in a liquid tin solution.<br><br>**Note:** This operation makes soldering the components easier and prevents the copper from oxidising.<br><br>*** IMPORTANT:** It is recommended to carry out this operation under the hood or to ensure the room is well ventilated. |  <br>«Liquid tin» | – Laboratory hood<br>– Safety glasses<br>– Liquid tin bath<br>– Plastic tweezers<br>– Timer |
| 82 | Rinse in the "tinning" water bath and sponge off without rubbing. |  | – Safety glasses<br>– Water bath<br>– Plastic tweezers<br>– Absorbent paper |
| 83 | **Now it is time the verify the state of electrical conductivity of this plate (see following section).**<br><br>**Once this verification has been carried out, the plate will be ready to have its components installed.** |  | |

# Controlling the state of conductivity of the Gaussmeter plate

Here is the Gaussmeter printed circuit. The grey areas are conductive and tinned. The white lines are insulating borders stripped of conductor.

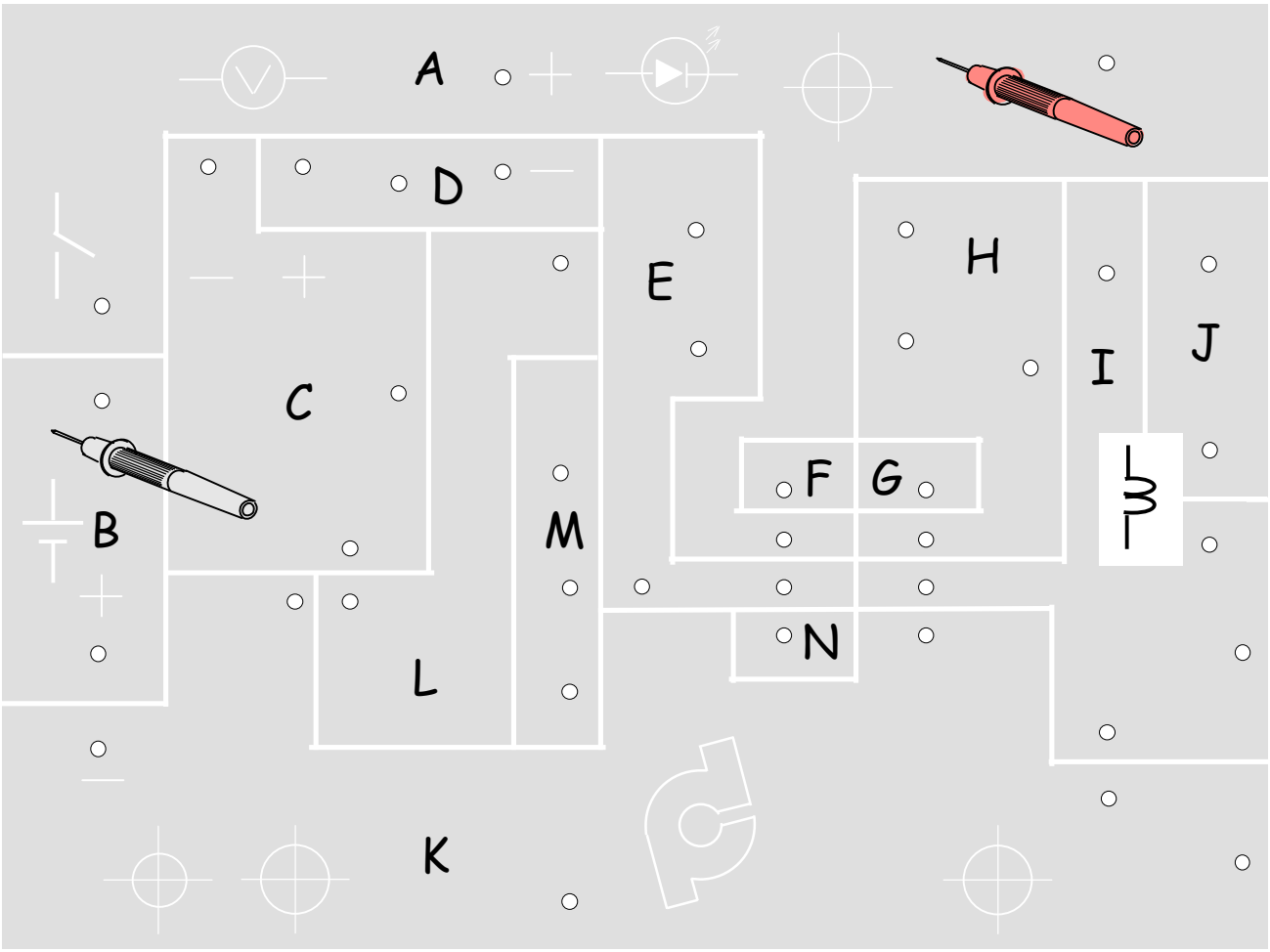


First, we must verify the electrical conductivity of each area. A fabrication defect may occur when the photosensitive resin is scratched before the engraving stage. Let's take textured area "A" below as an example: we need to test the conductivity between two distant points using a multi-meter in conduction mode. If the conductivity is good, we tick the control points in the table below. When the area has a more complex shape, additional measurements are necessary. If there were a defect, a dab of solder may re-establish conduction.

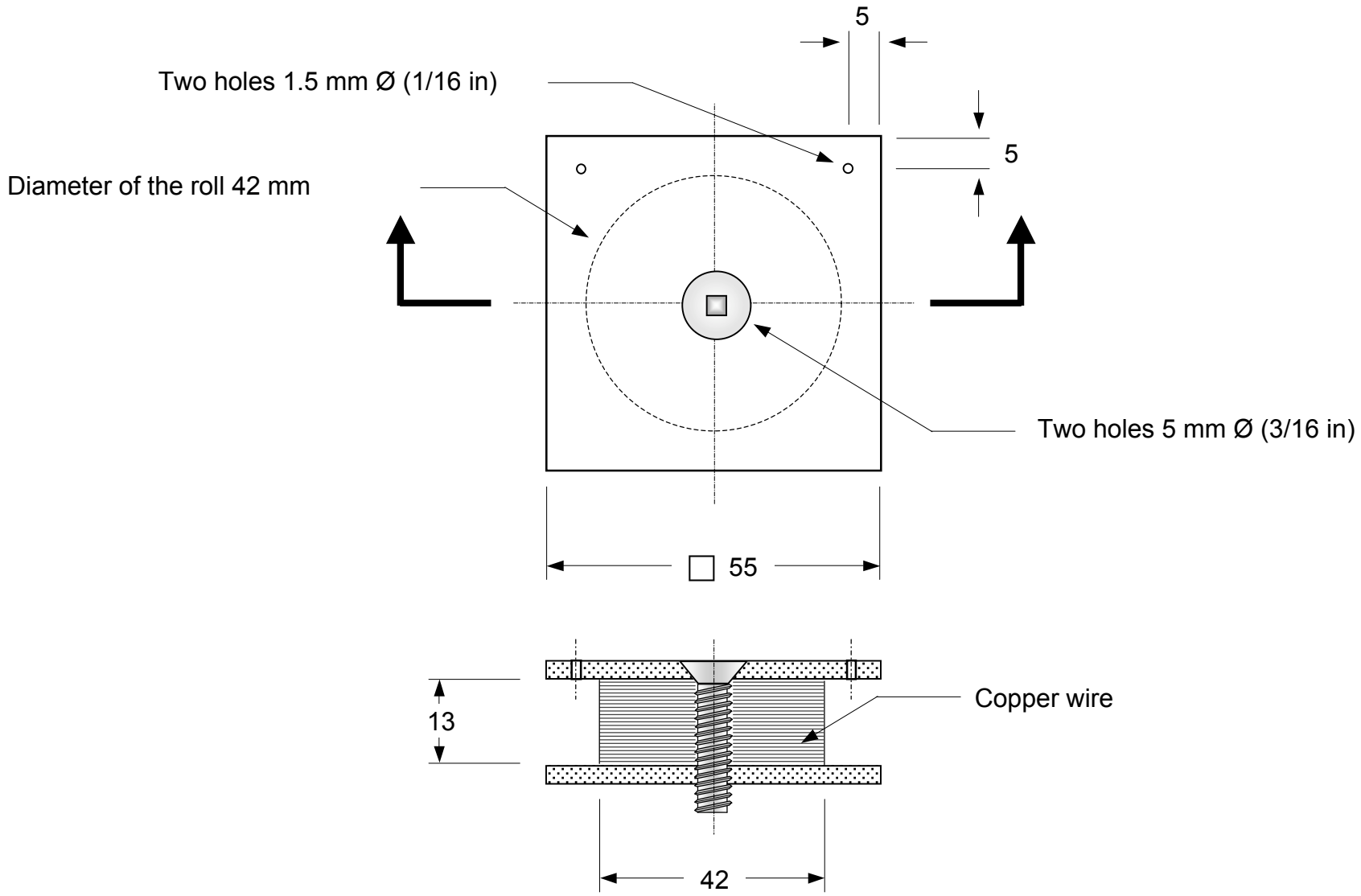



| Verification table for good conductivity in each area | | | | | | | |
|---|---|---|---|---|---|---|---|
| Control points | ✔ | Control points | ✔ | Control points | ✔ | Control points | ✔ |
| $A_1$ to $A_2$ | | $B_1$ to $B_2$ | | $B_1$ to $B_3$ | | $C_1$ to $C_2$ | |
| $D_1$ to $D_2$ | | $E_1$ to $E_2$ | | $F_1$ to $F_2$ | | $G_1$ to $G_2$ | |
| $G_1$ to $G_3$ | | $G_1$ to $G_4$ | | $H_1$ to $H_2$ | | $I_1$ to $I_2$ | |
| $I_1$ to $I_3$ | | $I_1$ to $I_4$ | | $J_1$ to $J_2$ | | $K_1$ to $K_2$ | |

Secondly, we need to test if the borders insulate correctly. A fabrication defect may arise when we superimpose the masks or when we print them. This time, we need to check that electrical current does not travel between adjacent areas (see example below between areas **A** and **B**). If the insulation is adequate, we will tick the control points in the table below. If there were a defect, it would be possible to separate the two areas by scratching the borders using the point of a plastics knife.




| Verification table for border insulation | | | | | | | |
|---|---|---|---|---|---|---|---|
| Control points | ✔ | Control points | ✔ | Control points | ✔ | Control points | ✔ |
| A and B | | A and C | | A and D | | A and E | |
| A and F | | A and G | | A and H | | A and I | |
| A and J | | K and B | | K and C | | K and L | |
| K and M | | K and E | | K and N | | K and I | |
| B and C | | C and D | | C and L | | D and L | |
| D and E | | L and E | | L and M | | M and E | |
| E and N | | E and I | | E and H | | N and I | |
| F and G | | F and H | | G and H | | H and I | |
| I and J | | | | | | | |

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| | | |
|---|---|---|
| ACTIVITY: «Gaussbusters» LES | | |
| NAME: Gaussmeter subset drawings (solenoid) | | |
| DATE: May 19, 2011 | SCALE: **1 = 1** | DRAWING: **N° 3** |

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# FABRICATION AND ASSEMBLY RANGE

ELEMENT: **SOLENOID**

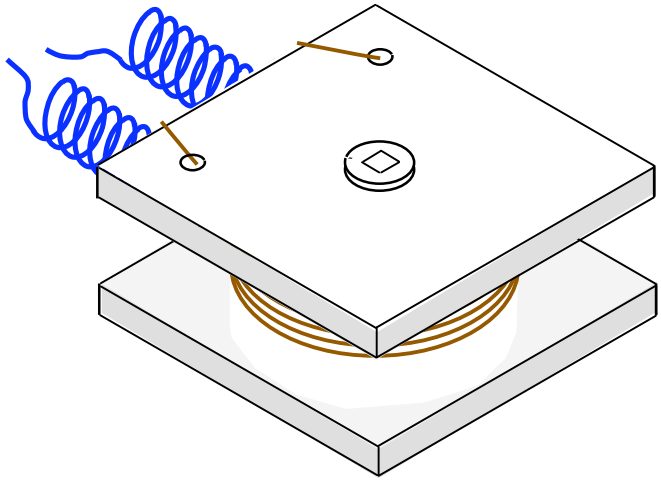
SET: **GAUSSMETER**

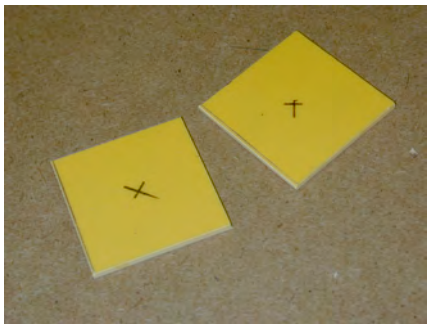
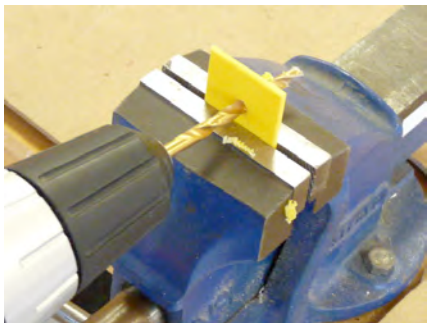
RANGE: **2**

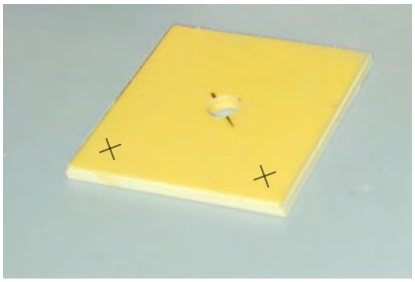
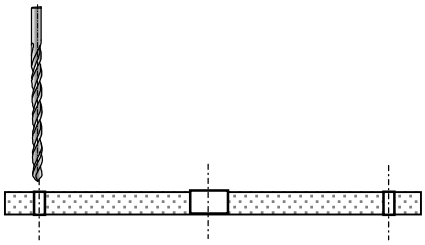
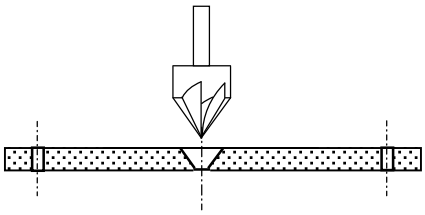
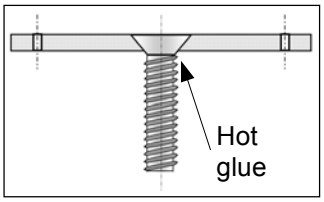
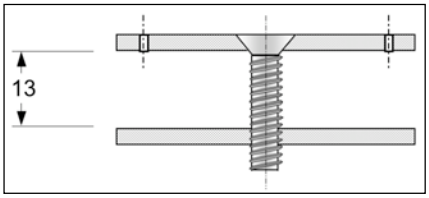
SHEEET: **1 of 3**

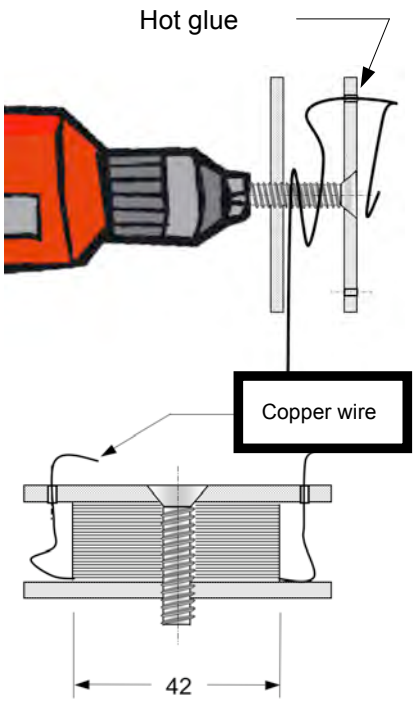
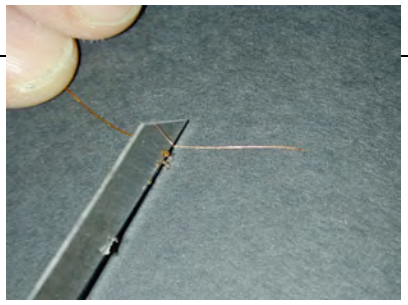
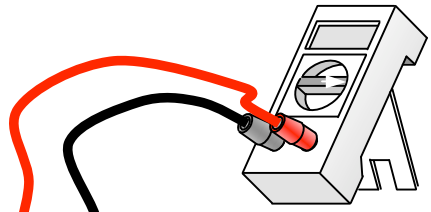
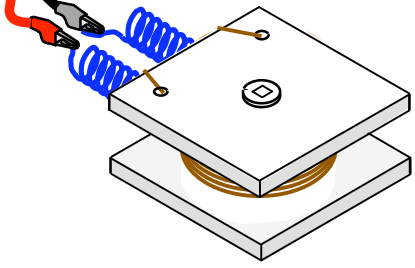
MATERIALS: **Various**

NUMBER: **1**

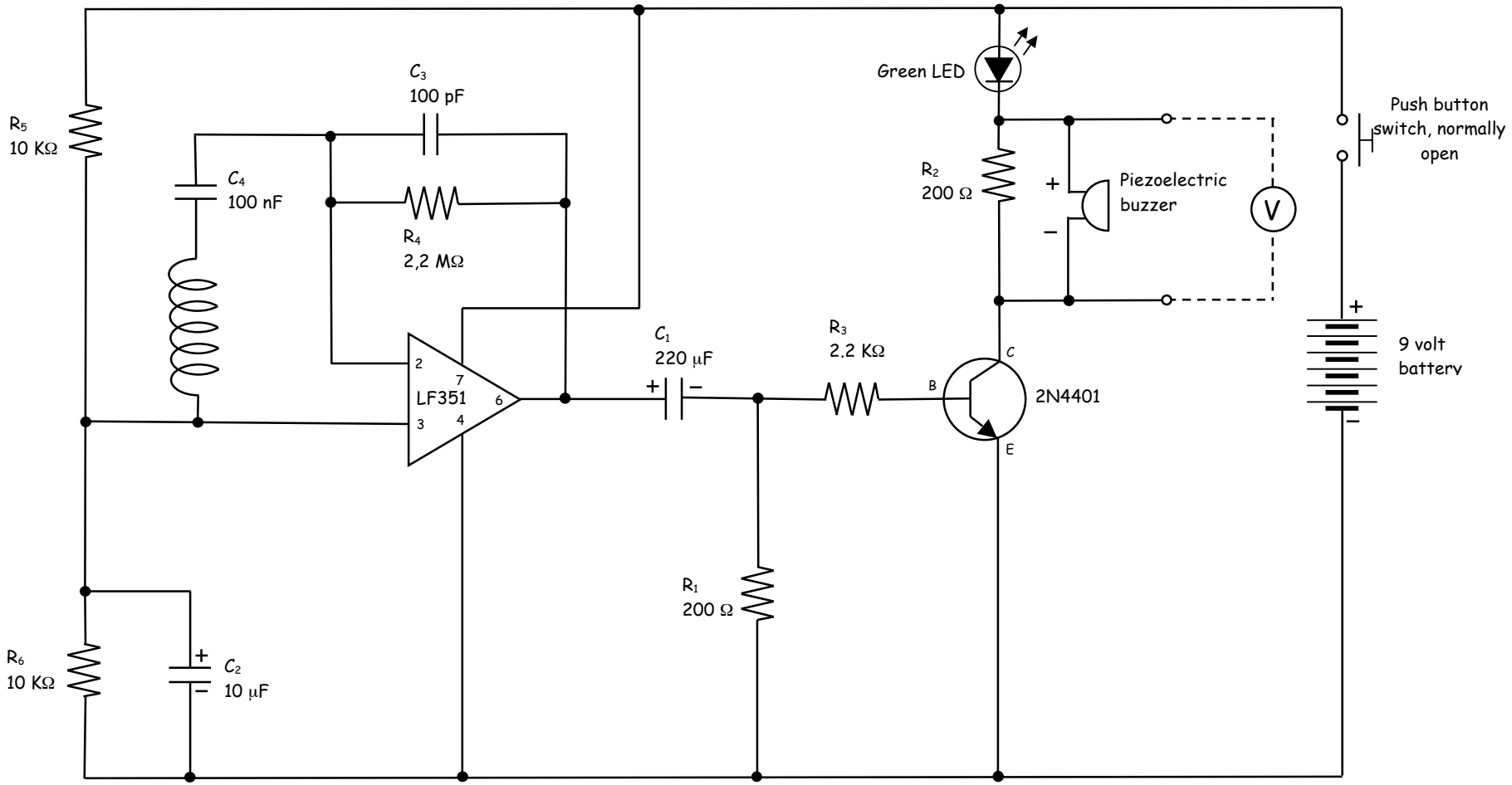


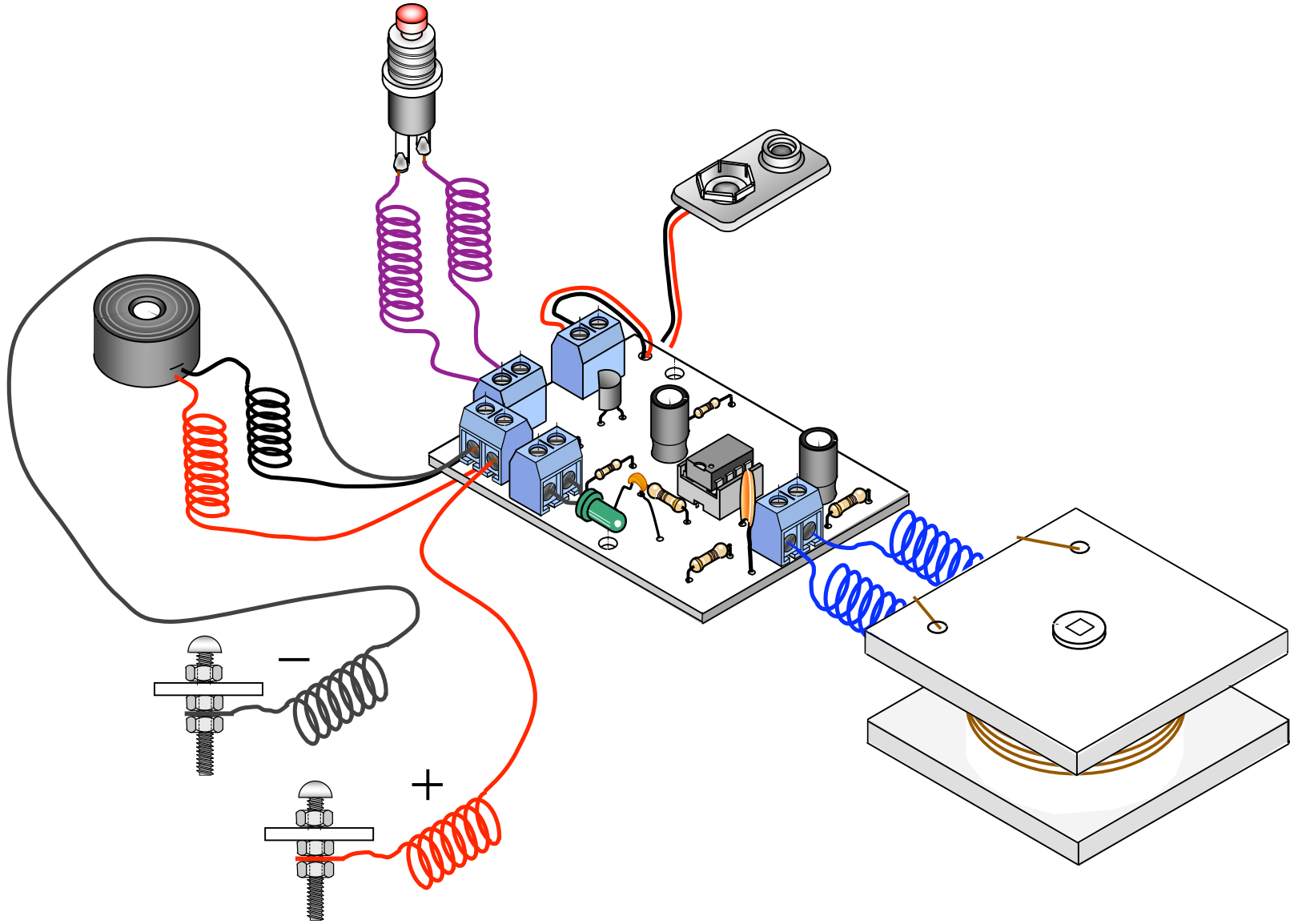
| N° | PHASE, SUB-PHASE OR OPERATION | PHOTO OR DRAWING | MACHINE-TOOL, TOOLS |
|---|---|---|---|
| 10 | TRACING |  | - Ruler<br>- Pencil<br>- Square |
| 11 | On a piece of polystyrene, trace two 55 mm squares and mark the centers. These pieces will be the upper and lower butt plates for the solenoid. These butt plates could also be 55 mm diameter circles. | | |
| 20 | CUTTING |  | - Plastics knife<br>- Safety ruler<br><br>- Scraper<br>- Sand paper |
| 21 | Using a plastics knife, cut out the butt plates. | | |
| 22 | Finish the edges with a scraper and sand paper. | | |
| 30 | DRILLING |  | - Punch<br>- Hammer<br><br>- Hand drill<br>- Vice<br>- 5 mm (3/16 in) Ø bit |
| 31 | Punch the holes. | | |
| 32 | Affix the butt plate in a vise and using a 5 mm Ø bit, drill the hole. | | |
| 33 | Repeat the same operations for the second butt plate. | | |

| FABRICATION AND ASSEMBLY RANGE FOR THE SOLENOID | | | SHEET: **2 of 3** |
|---|---|---|---|
| **N°** | **PHASE, SUB-PHASE OR OPERATION** | **PHOTO OR DRAWING** | **MACHINE-TOOL, TOOLS** |
| 40 | TRACING |  | - Pencil<br>- Ruler<br>- Square |
| 41 | On the upper butt plate, mark the location of two holes, 5 mm from the edge. | | |
| 50 | DRILLING |  | - Punch<br>- Hammer<br>- Vise<br>- Hand drill<br>- 1.5 mm (1/16 in) Ø bit |
| 51<br>52 | Punch the two holes.<br>Affix the parts in a vise and drill two holes with a 1.5 mm Ø.<br>The copper wires will be threaded through these holes. | | |
| 60 | COUNTER SINKING |  | - Vise<br>- Hand drill<br>- Counter sink bit<br>**- Drawing n°3** |
| 61 | Affix the parts in a vise and counter sink the center hole in the upper butt sufficiently deep to insert the screw head (see drawing n° 3). | | |
| 70 | TAPPING |  | - Vise<br>- Screwdriver |
| 71 | Screw a 1/4 inch diameter screw into the lower butt plate, perpendicular to the surface (the screw will tap the hole). | | |
| 72 | Withdraw the screw after tapping. | | |
| 80 | ASSEMBLY |  <br>  | - Screwdriver<br>- Hot glue gun |
| 81 | Using hot glue, assemble a counter sink screw (one inch long with a 1/4 inch diameter) onto the upper butt plate. | | |
| 82 | Screw the lower butt plate onto the screw leaving a 13mm space between the two plates. | | |

| FABRICATION AND ASSEMBLY RANGE FOR THE SOLENOID | | | SHEET: **3 of 3** |
|---|---|---|---|
| **N°** | **PHASE, SUB-PHASE OR OPERATION** | **PHOTO OR DRAWING** | **MACHINE-TOOL, TOOLS** |
| 90 | WINDING |  | |
| 91 | Affix the hand drill into a vise. | | - Hand drill |
| 92 | Affix the two butt plates assembled with the screw into the drill chuck. | | - Vise |
| 93 | Thread the end of the copper wire into one of the 1.5 mm diameter holes. | | - 32 gauge enamelled copper wire |
| 94 | Glue the end of the wire with a drop of hot glue. | | - Hot glue gun |
| 95 | Temporarily affix the extra wire onto the screw head with a piece of adhesive tape. | | - Adhesive tape |
| 96 | Wind the copper wire until the diameter of the solenoid is approximately 42 mm (use the vernier calliper to measure the diameter). | | - Vernier calliper |
| 97 | Cut the copper wire and insert it into the other 1.5 mm diameter hole. | | - Wire cutters |
| 98 | Affix this other end of the wire using a drop of hot glue. | | |
| 100 | VERIFYING CONDUCTIVITY |  | |
| 101 | Remove the enamel from the end of the solenoid wires by scratching it with the blade of a utility knife. Fine sand paper could also be used. | | - Utility knife |
| 102 | Check the conductivity of the solenoid by connecting its extremities to the terminals of a multi meter in conduction mode. |  | - Multi meter |
| | **There you go !**<br><br>**Your solenoid is ready. All you have left to do is to connect it to the circuit of the Gaussmeter.** |  | |

# Diagram of the electronic circuit of the Gaussmeter



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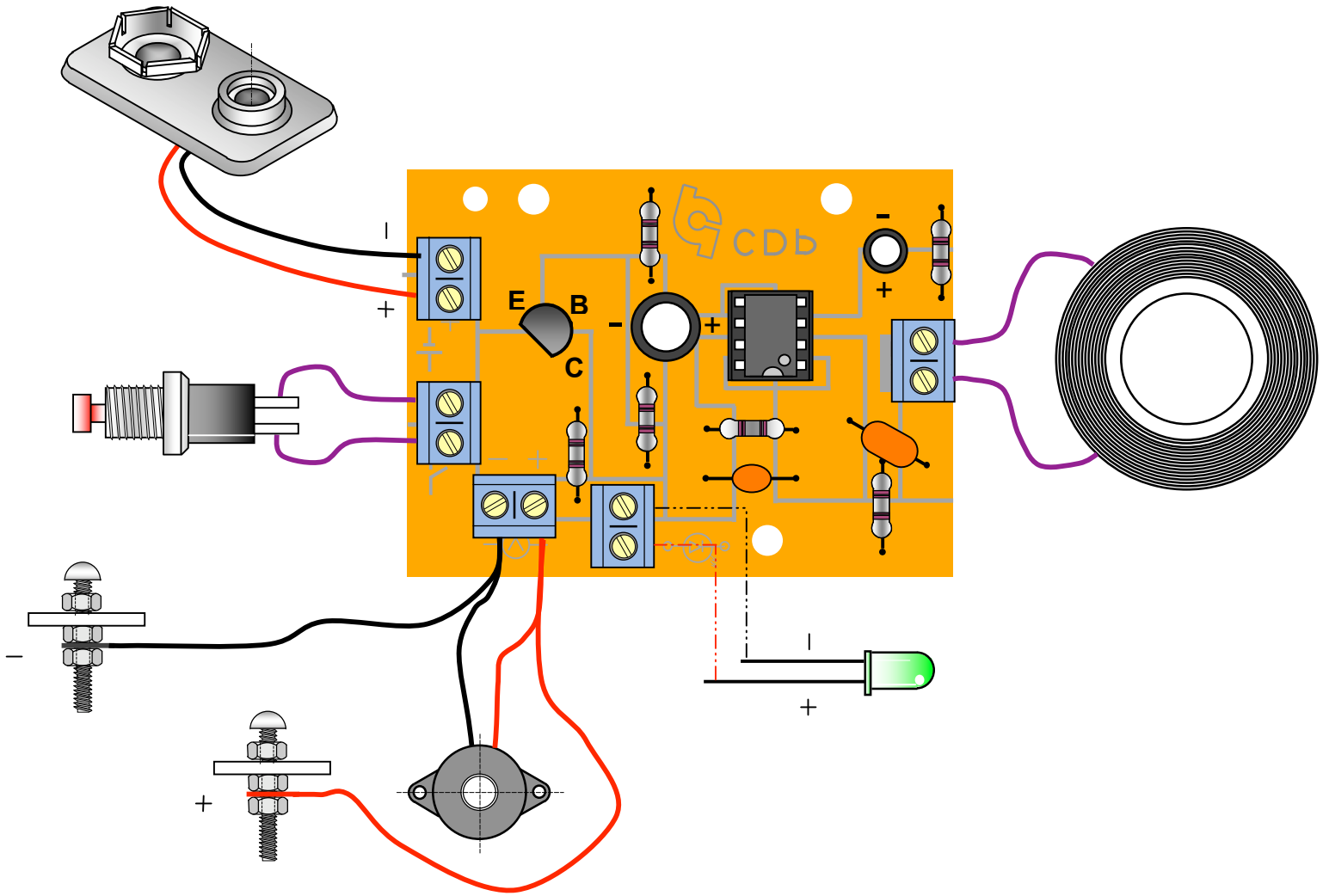
| | | | |
|---|---|---|---|
| ACTIVITY: | **«GAUSSBUSTERS» LES** | | |
| NAME: | **GAUSSMETER CIRCUIT** | | |
| DATE: | **MAY 2011** | SCALE: **NOT TO SCALE** | DRAWING: **N$^{o}$ 1** |

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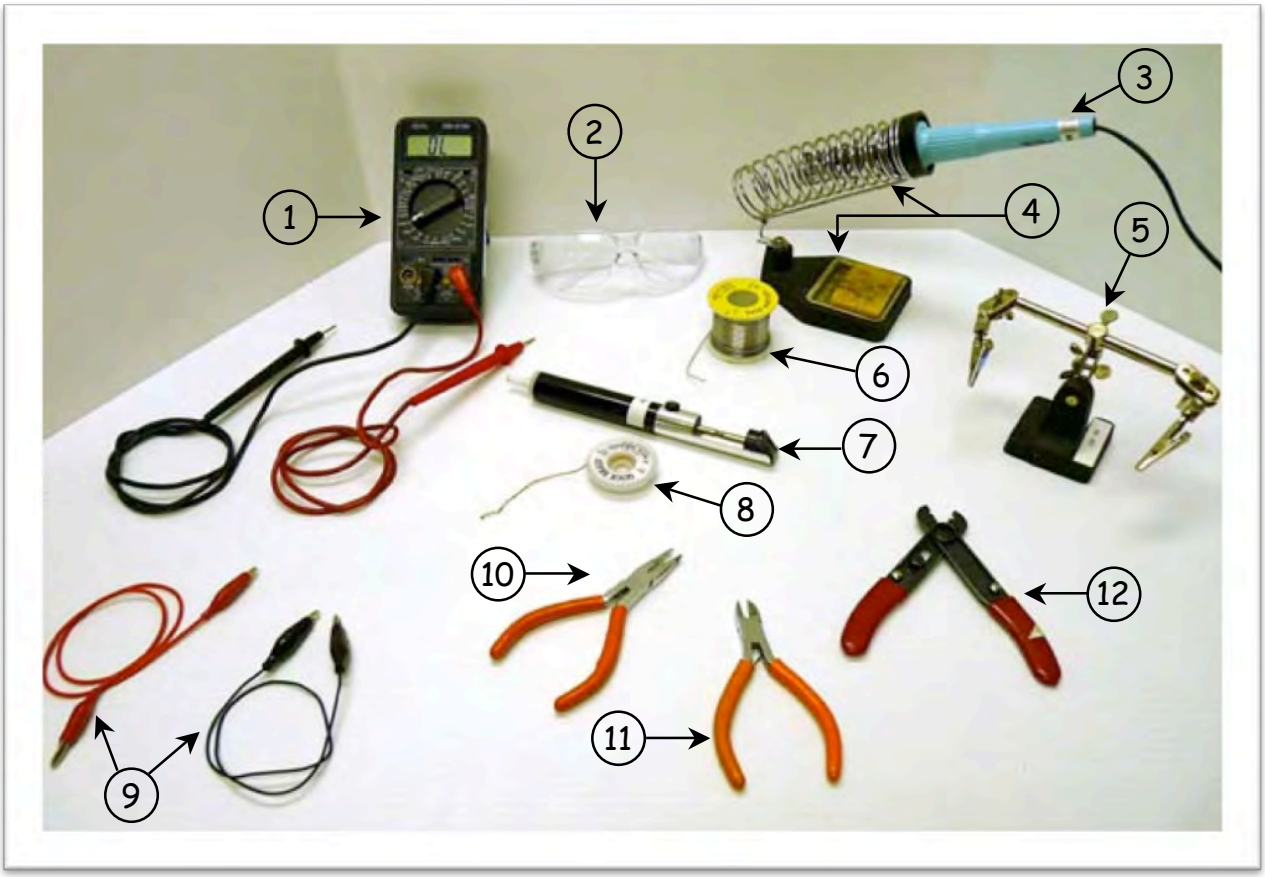
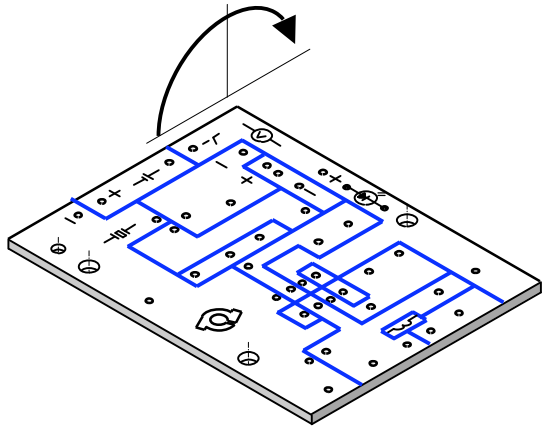
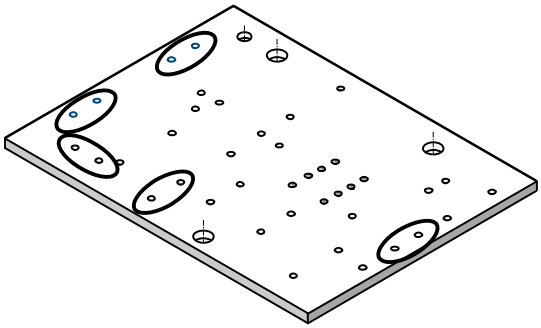
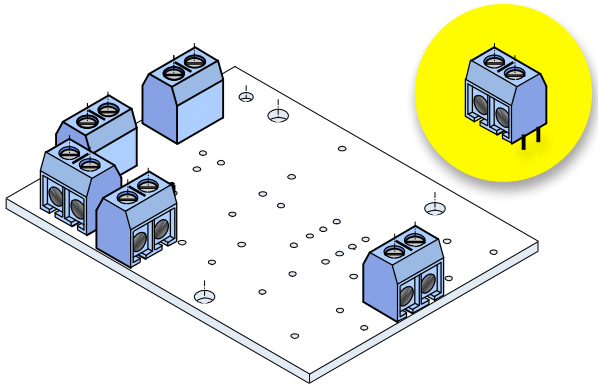
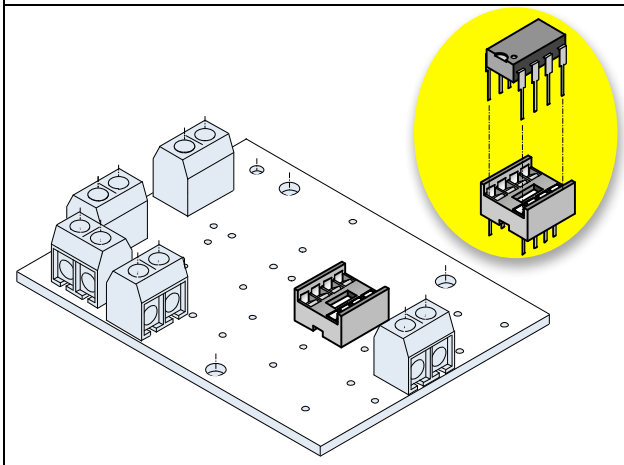
| | | |
|---|---|---|
| ACTIVITY: **«GAUSSBUSTERS» LES** | | |
| NAME: **GAUSSMETER CIRCUIT (top view)** | | |
| DATE: **May 2011** | SCALE: **NOT TO SCALE** | DRAWING: **N° 2** |

# Equipment used for soldering

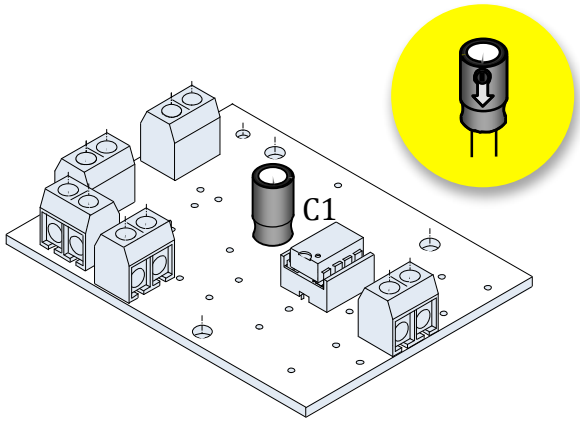
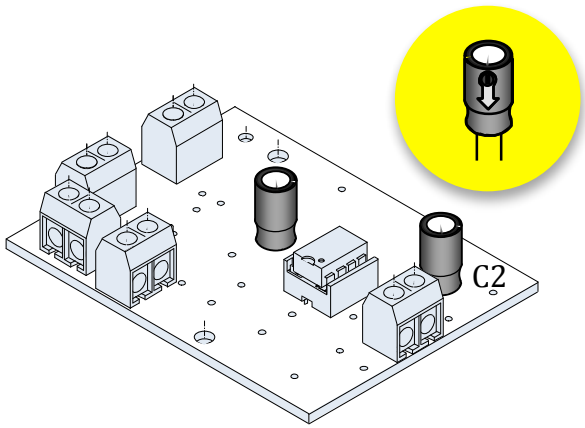
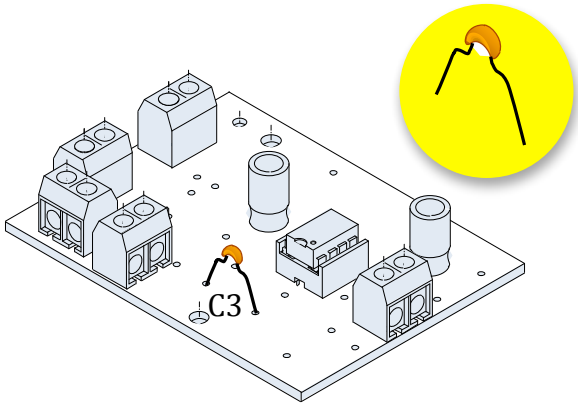
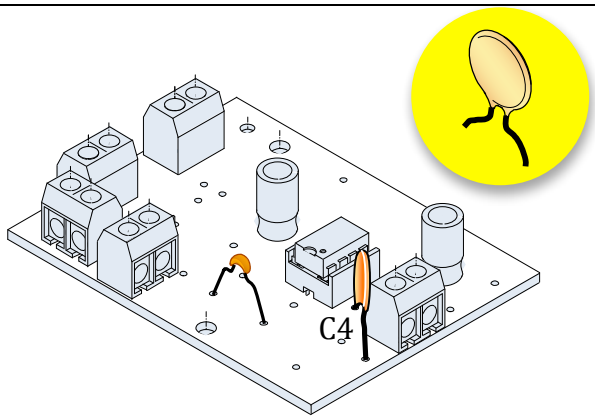



1. Multi-meter
2. Safety glasses
3. Soldering iron
4. Iron stand and sponge
5. Card holder vise (soldering vise)
6. Flux (tin)
7. De-soldering pump
8. De-soldering braid
9. Alligator clip wires
10. Needle nosed pliers
11. Wire cutters
12. Wire strippers

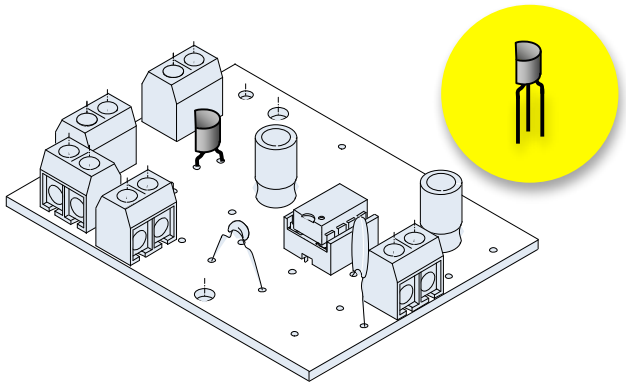
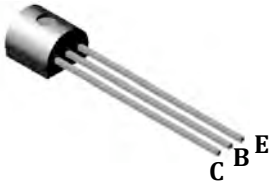
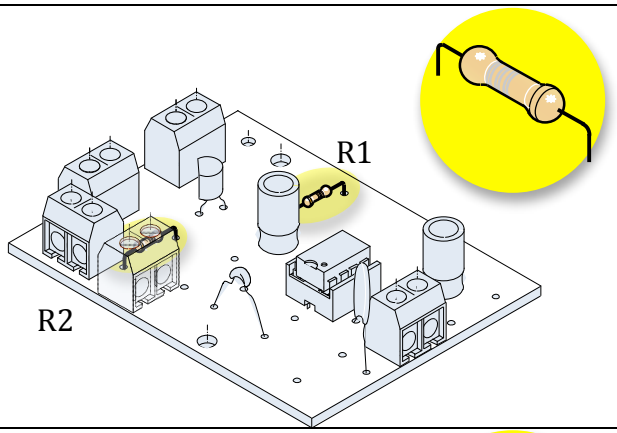
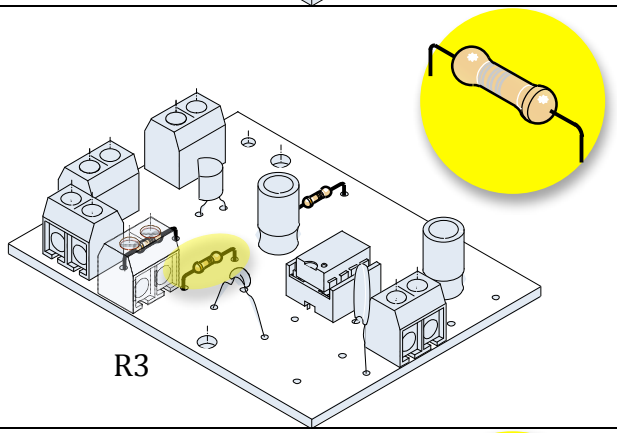
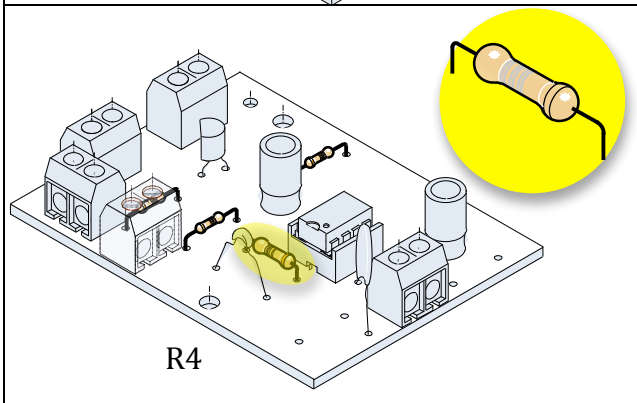
# GAUSSMETER COMPONENT INSTALLATION PROCEDURE

| | |
|---|---|
|  | Verify the state of conductivity of the circuit before installing the first component.<br><br>Pivot the circuit plate, copper side towards the table (CDP logo is face to the table). |
|  | On the insulated surface of the plate, find the locations for the 5 connectors.<br><br>See **drawing #2** to find the locations and directions of the connectors. |
|  | Solder the five connectors in the locations found in the step above. |
|  | Solder the base for the integrated circuit.<br>**Important**: Do not install the integrated circuit while soldering its base. The heat of the soldering iron may damage the integrated circuit.<br><br>See **drawing #2** to find the direction for the integrated circuit. |

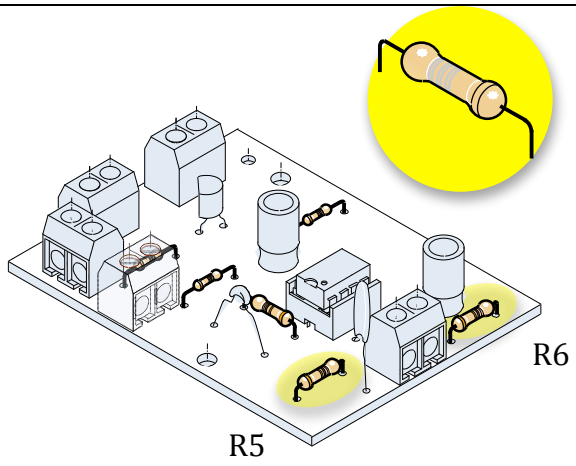
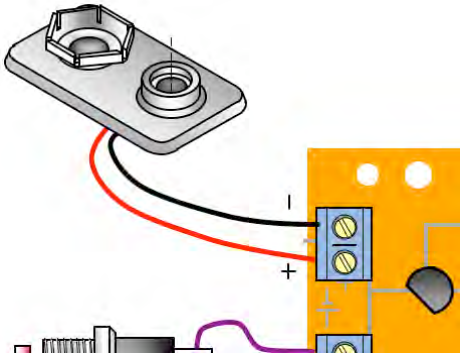
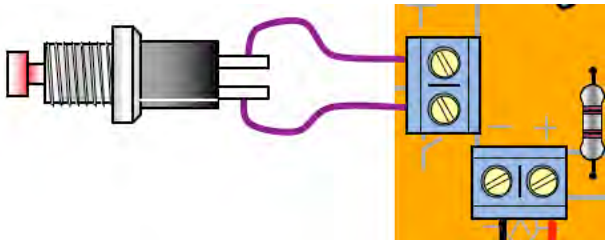
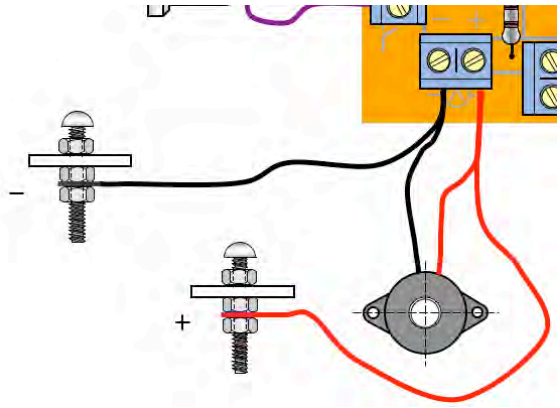
## GAUSSMETER COMPONENT INSTALLATION PROCEDURE (continued)

| | |
|---|---|
|  | Solder the electrolytic capacitor.<br><br>C1: **220 µF**<br>**Watch the polarity**<br><br>See **drawing #2** to find the location and the polarity for the capacitor. |
|  | Solder the electrolytic capacitor.<br><br>C2: **10 µF**<br>**Watch the polarity**<br><br>See **drawing #2** to find the location and the polarity for the capacitor. |
|  | Solder the ceramic capacitor.<br><br>C3: **100 pF**<br>**Watch the value of the component**<br><br>See **drawing #2** to find the location for the capacitor. The shape of the capacitor may differ. |
|  | Solder the ceramic capacitor.<br><br>C4: **100 nF**<br>**Watch the value of the component**<br><br>See **drawing #2** to find the location for the capacitor. The shape of the capacitor may differ. |

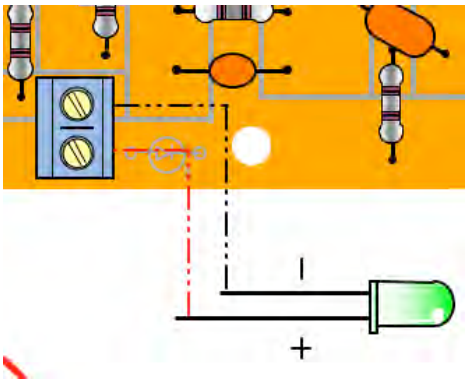
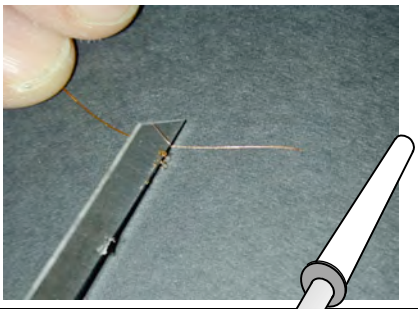
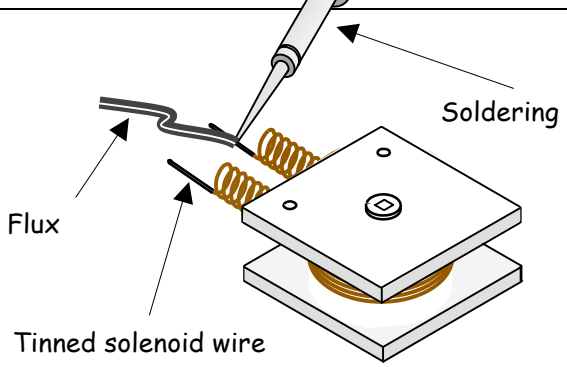
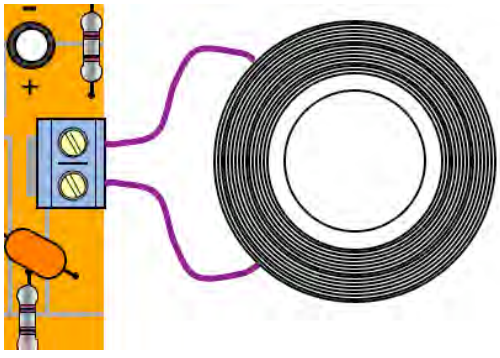
## GAUSSMETER COMPONENT INSTALLATION PROCEDURE (continued)

<table>
<tr>
<td>  </td>
<td>Solder the NPN transistor.<br><br>Watch the directio  <br><br><br>See drawing #2 to find the location and the direction for the transistor.</td>
</tr>
<tr>
<td>  <br></td>
<td>Solder the R1 and R2 resistors.<br><br>R1 and R2: 200 Ω (red, black, brown)<br><br>See drawing #2 to find the location of the resistor.</td>
</tr>
<tr>
<td>  <br></td>
<td>Solder resistor R3.<br><br>R3: 2.2 KΩ (red, red, red)<br><br>Check the value of the component.<br><br>See drawing #2 to find the location of the resistor.</td>
</tr>
<tr>
<td>  <br></td>
<td>Solder resistor R4.<br><br>R4: 2.2 MΩ (red, red, green)<br><br>Check the value of the component.<br><br>See drawing #2 to find the location of the resistor.</td>
</tr>
</table>

## GAUSSMETER COMPONENT INSTALLATION PROCEDURE (continued)

| | |
|---|---|
|  | Solder resistors R5 and R6.<br><br>R5 and R6 : **10 KΩ (brown, black, orange)**<br><br>See **drawing #2** to find the location of the resistor. |
|  | Connect the 9V battery connector to the appropriate terminals, respecting their polarity.<br><br>See **drawings #1 and #2** for more details and for a set view. |
|  | Connect the push-button switch to the appropriate terminals.<br><br>See **drawings #1 and #2** for more details and for a set view. |
|  | Connect the (optional) piezoelectric buzzer and the voltmeter connector screws to the appropriate terminals, while respecting the polarity.<br><br>See **drawings #1 and #2** for more details and for a set view. |

## GAUSSMETER COMPONENT INSTALLATION PROCEDURE (continued)

| | |
|---|---|
|   | Connect the light emitting diode (LED) to the provided terminals, respecting the polarity.<br><br>It may be necessary to add a wire depending on the position of the LED in the housing.<br><br>See **drawings #1 and #2** for more details and for a set view. |
|  | If it hasn't already been done, remove the varnish from the ends of the solenoid wires by scratching them with the blade of a utility knife.<br><br>Sandpaper may also do the job. |
|   | Tinning the extremities also improves the contact with the connector. |
|   | Connect the solenoid to the provided terminals.<br><br>See **drawings #1 and #2** for more details and for a set view. |
| **After having connected the battery, the circuit should be functional. If this is not the case, consult the next section, "Verifying the operating state of the Gaussmeter". This section should help you troubleshoot the problem.** | |

# Controlling the state of operation of the Gaussmeter

Here is a troubleshooting process that will guide you if your Gaussmeter does not work. This process should help you identify any anomalies. It is important to follow this process in the suggested order, since the most frequent problems are listed first.

## Preliminary verifications

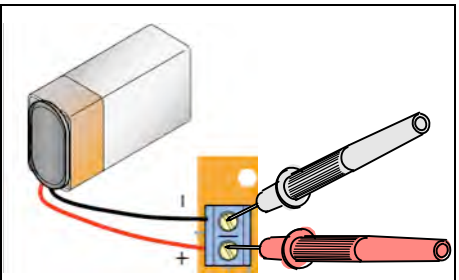
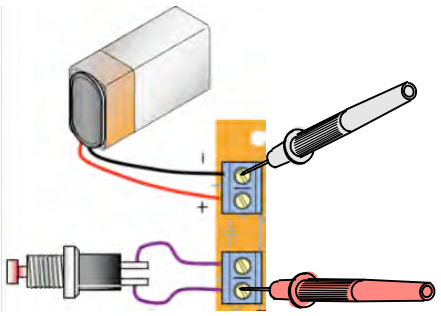
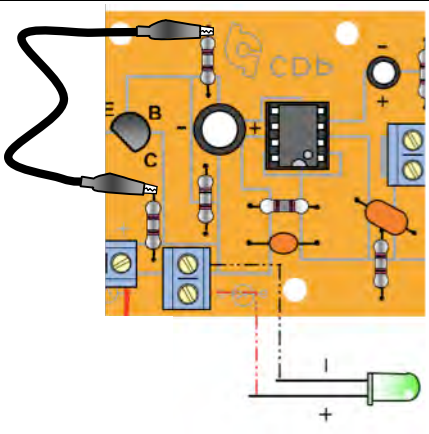
**Check the following points and tick the box once you're done.**

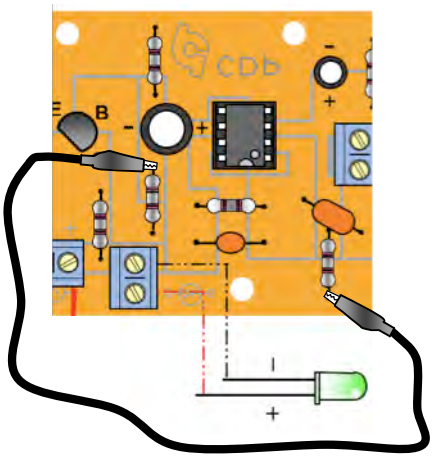
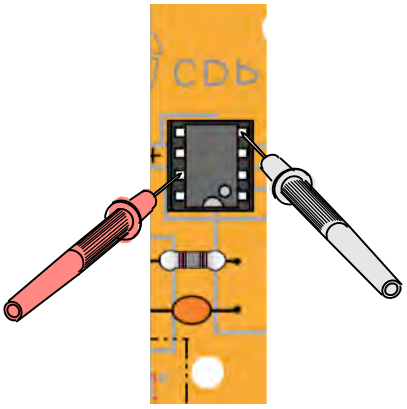
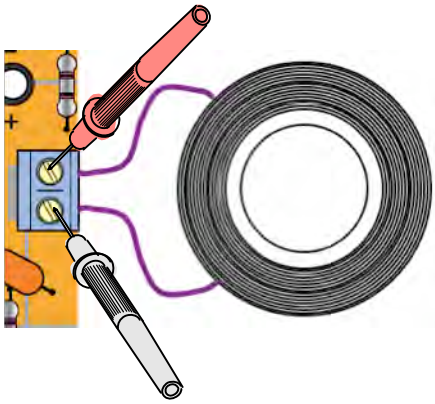
- [ ] 1. If you did not verify the state of conductivity of your plate before installing the components (see student booklet) you are not in an ideal position. A visual examination of the circuit may help you to detect certain anomalies.
- [ ] 2. Check the state of the battery using a multi meter in voltage mode (≈ 9 V).
- [ ] 3. Visually check the state of all your solders (those on the plate as well as the external components connected with wires) by consulting the tin soldering section of the student booklet. If in doubt, solder them again.
- [ ] 4. Check that all the components to be soldered are truly present on the plate by consulting Gaussmeter circuit drawing n° 2.
- [ ] 5. Check that you have not switched the two electrolytic capacitors (220 μF and 10 μF) by consulting the component installation procedures.
- [ ] 6. Check the polarity of the two electrolytic capacitors (220 μF and 10 μF) by consulting Gaussmeter circuit drawing n° 2.
- [ ] 7. Check that you have not switched the two ceramic capacitors (100 pF and 100 nF) by consulting the component installation procedures.
- [ ] 8. Check the value of the resistors by consulting the component installation procedures.
- [ ] 9. Check the direction of the transistor connection by consulting Gaussmeter circuit drawing n° 2.
- [ ] 10. Check the direction of the integrated circuit connection by consulting Gaussmeter circuit drawing n° 2. **Please note that connecting an integrated circuit in the opposite direction may seriously damage it.**
- [ ] 11. Check that all the external components (9V battery, switch, buzzer, multi meter, LED, solenoid) are actually there by consulting Gaussmeter circuit drawing n° 2.
- [ ] 12. Check that all the external components are connected to the right connectors by consulting Gaussmeter circuit drawing n° 2. **Please note that a battery connected in the opposite direction may seriously damage the integrated circuit.**
- [ ] 13. Check the polarity of the 9V battery connector.
- [ ] 14. Check the polarity of the LED.
- [ ] 15. Check the polarity of the piezoelectric buzzer.

## Connector verifications

If the Gaussmeter is still not functional after all these verifications, your investigation has to be pushed a little further. Here are various voltage and resistance measurements that can orient your research. You should have **drawing n° 2** close at hand for these verifications.

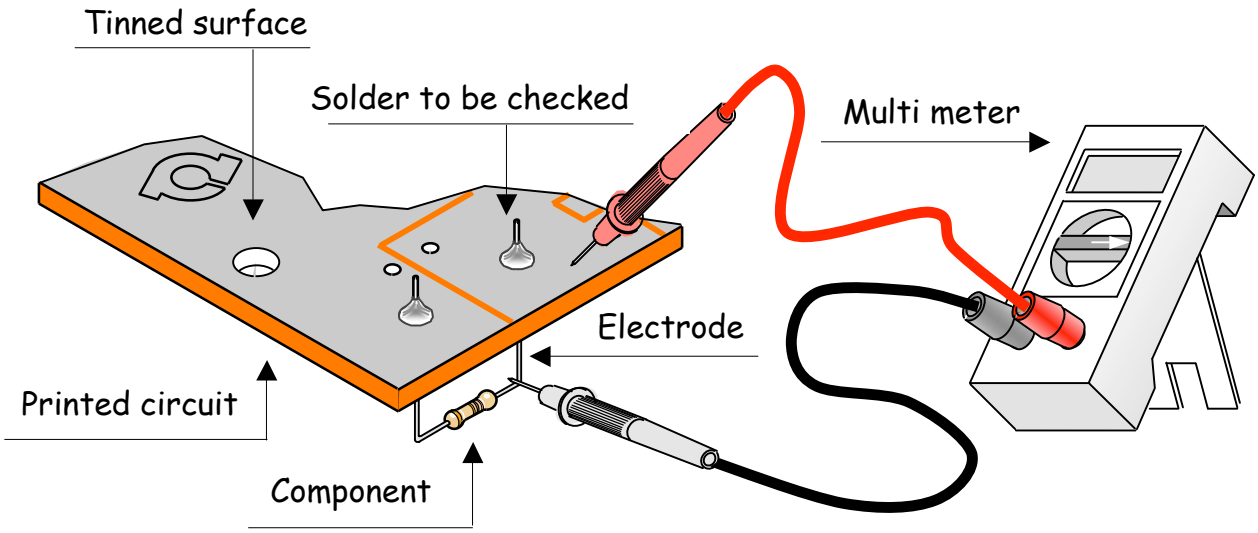
- If nothing happens when you push the switch, start your research at step 1 below.
- If when you push the switch, the LED flashes and a "beep" sounds without detecting an electromagnetic field, you're almost there: go directly to step 6.
- If when you push the switch, the LED lights up without hearing the "beep", check the solders for the buzzer and its connector (see the plate solder verification section that follows).

| | | |
|---|---|---|
| **1** | **Checking the power supply**<br>Connect the battery and measure the voltage at the connector. The voltage should be about 9 volts. If this is not the case, it is possible the wires were not correctly stripped, thus producing a poor contact in the connector. The battery connector may also be defective. |  |
| **2** | **Checking the switch**<br>Press the switch and measure the voltage as illustrated on the drawing at right. There should be about 9 volts. If this is not the case, it is possible the switch wires were not correctly stripped, thus producing a poor contact in its connector. You must also check the battery connector and the switch solders (see the plate solder verification section that follows). |  |
| **3** | **Checking the LED**<br>Press the switch and connect an alligator clip wire as shown at right. The LED should light up and the buzzer sound. If this is not the case, perhaps the LED wires were not correctly stripped, thus producing a poor contact in its connector. The LED connector and $R_2$ and $R_1$ resistor solders need also be checked (see the plate solder verification section that follows). |  |

| | | |
|---|---|---|
| **4** | **Checking the transistor**<br>Press the switch and connect an alligator clip wire as shown at right. The LED should light up and the buzzer sound. If this is not the case, the transistor and $R_3$ and $R_5$ resistor solders need to be checked (see the plate solder verification section that follows). |  |
| **5** | **Checking the power supply for the integrated circuit**<br>Press the switch and measure the voltage as illustrated on the drawing at right. There should be about 9 volts. If this is not the case the integrated circuit housing solders need to be checked (see the plate solder verification section that follows).<br>Before re-soldering it, carefully remove the integrated circuit using a small flathead screwdriver so that the heat does not damage the chip. |  |
| **6** | **Checking the solenoid**<br>**Without pressing the switch,** measure the electrical resistance at the solenoid terminals as illustrated on the drawing at right. You should measure a resistance of about 200 Ω ± 10%. This value may differ if the wire used for winding was not #32 calibre. The thickness of the solenoid, as well as the number of times the wire was wound also influence the measured resistance.<br>If the resistance is infinite, the connector solders and the extremities of the solenoid need to be checked (ends well scratched off and tinned). The wire may also have broken while winding. In this case, the solenoid needs to be replaced. |  |

## Plate solder verifications

If the Gaussmeter is still not functional, you have to look elsewhere. Even if the solders seem good, poor contacts may be hidden. Here is how to proceed to find these faulty solders. Note that the circuit must not be powered during these verifications.




**Manipulations**

1. Adjust the multi meter to conduction mode (buzzer or ohmmeter).
2. Firmly press one of the multi meter connectors onto the component electrode.
3. Place the other multi meter connector on the tinned surface close to the solder to be checked.
4. Apply pressure (in several directions) on the component in order to test the solder.
5. If the multi meter sounds continuously, the solder is indeed good.
6. If the multi meter can not be heard, or if it is intermittent, the solder must be redone by adding a little flux.
7. Repeat steps 2 to 6 for all the other solders in the assembly.

# Gaussmètre (Coût février 2011)

| Name of the part | Description | No. | Cost per part | Total | Supplier | Part number | Supplier contact details |
|---|---|---|---|---|---|---|---|
| 9V battery connector | | 1 | $0,33 | $0,33 | Digi-Key | BS12I-HD-24AWG-ND | |
| Push button switch | Normally open (NO) Push button switch | 1 | $1,24 | $1,24 | Digi-Key | SW628-ND | http://www.maddison.ca/ |
| Green LED | Green/amber light emiting diode (5 mm. dia.) | 1 | $0,11 | $0,11 | Digi-Key | 754-1263-ND | http://www.digikey.com/ |
| Resistors | 200 Ω 1/4 watt power | 2 | $0,08 | $0,16 | Digi-Key | CF14JT200RCT-ND | http://www.cyme.biz |
| NPN Transistor | 2N4401 | 1 | $0,38 | $0,38 | Digi-Key | 2N4401GOS-ND | |
| Multi meter terminals | Mono terminal for speaker 2"x1" (+ and -) | 1 | $0,45 | $0,45 | Maddison | HY3203 / C-10112 | |
| Resistors | 2,2 kΩ 1/4 watt power | 1 | $0,08 | $0,08 | Digi-Key | CF14JT2K20CT-ND | |
| Buzzer | Piezoelectric buzzer | 1 | $2,36 | $2,36 | Digi-Key | 458-1066-ND | |
| Capacitor | 220 µF electrolytic capacitor 220 µF (min. 5V) | 1 | $0,20 | $0,20 | Digi-Key | P5112-ND | |
| Integrated circuit | LF351N amplifier | 1 | $0,92 | $0,92 | Digi-Key | 497-2966-5-ND | |
| Integrated circuit support | 2 x 4 | 1 | $0,21 | $0,21 | Digi-Key | 3M5461-ND | |
| Resistors | 2,2 MΩ 1/4 watt power | 1 | $0,08 | $0,08 | Digi-Key | CF14JT2M20CT-ND | |
| Capacitor | 100 pF (0,0001 µF) ceramic capacitor | 1 | $0,17 | $0,17 | Digi-Key | 490-4257-ND | |
| Capacitor | 100 nF (0,1 µF) ceramic capacitor | 1 | $0,16 | $0,16 | Digi-Key | 478-3156-1-ND | |
| Resistors | 10 kΩ 1/4 watt power | 2 | $0,09 | $0,18 | Digi-Key | P10KBACT-ND | |
| Capacitor | 10 µF (min. 10V) electrolytic capacitor | 1 | $0,20 | $0,20 | Digi-Key | P5134-ND | |
| 2 terminal connector | 2 screw terminal connector | 5 | $0,20 | $1,00 | Digi-Key | ED2600-ND | |
| Copper solenoid | 100 g of AWG #32 wire (4545 g = 10 pounds = 105 $) | 1 | $5,50 | $2,30 | Cyme | | |
| | | 1 | $0,00 | $0,00 | Digi-Key | | |
| | | 1 | $0,00 | $0,00 | Digi-Key | | |
| | | 1 | $0,00 | $0,00 | Digi-Key | | |
| | | 1 | $0,00 | $0,00 | Digi-Key | | |
| | | 1 | $0,00 | $0,00 | Digi-Key | | Grand total |
| | | 1 | $0,00 | $0,00 | Digi-Key | | $10,53 |