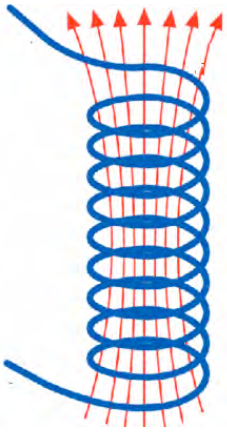
centre de développement pédagogique

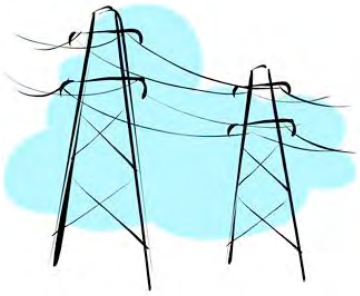
pour la formation générale en science et technologie

Working document

GAUSSBUSTERS



TEACHER AND TTP GUIDE



May 2011

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Introduction

NOTE: This activity was designed within the framework of teacher training sessions. It may require adaptation before being used with students.

Before moving forward with this LES, it would be preferable to have a look at the outline and the overview of the "Gaussbusters" task. These documents will allow you to have a more complete view of the activity. In addition, these documents locate the LES within the program by enumerating, among other things, the concepts and techniques that are broached. These documents will eventually be available online on our website, at the following address:
http://www2.cslaval.qc.ca/cdp/pages/secondaire-4.html

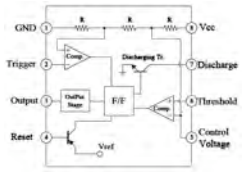
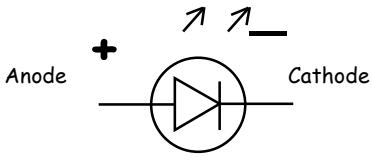
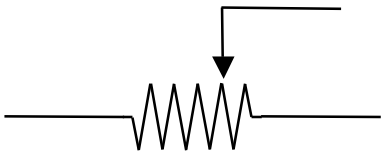
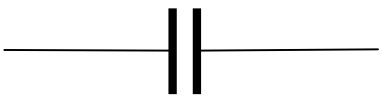
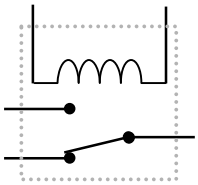
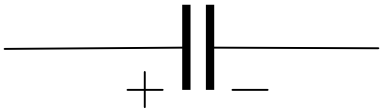
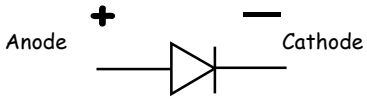
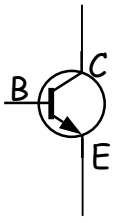
In the meantime, you can contact your pedagogical counsellor.

Can you recognise these components?

To carry out this exercise more concretely, it would be interesting to present the students with real components. Place an example of each component in a plastic bag without identifying it. A similar bag is given to each team. The objective is to place the real component next to the corresponding photo in the exercise below.

Since components can vary in shape and dimension, the bags need not be identical. Once the work is completed, the teams may circulate in class in order to see the other teams' work. This will allow for a greater variety of components and give rise to constructive discussions.

Using its letter, associate the name (in the center), to the symbol at left and to the photo at right.

	(J)	**(A) Fixed resistor**	(D)	
	(A)	**(B) Variable resistor**	(J)	
	(F)	**(C) Ceramic capacitor**	(B)	
	(B)	**(D) Electrolytic capacitor**	(E)	
	(C)	**(E) Ordinary diode**	(I)	
	(G)	**(F) Light emitting diode**	(C)	
	(D)	**(G) Relay**	(H)	
	(E)	**(H) Solenoid**	(F)	
	(H)	**(I) Bipolar transistor**	(A)	
	(I)	**(J) Integrated circuit**	(G)	

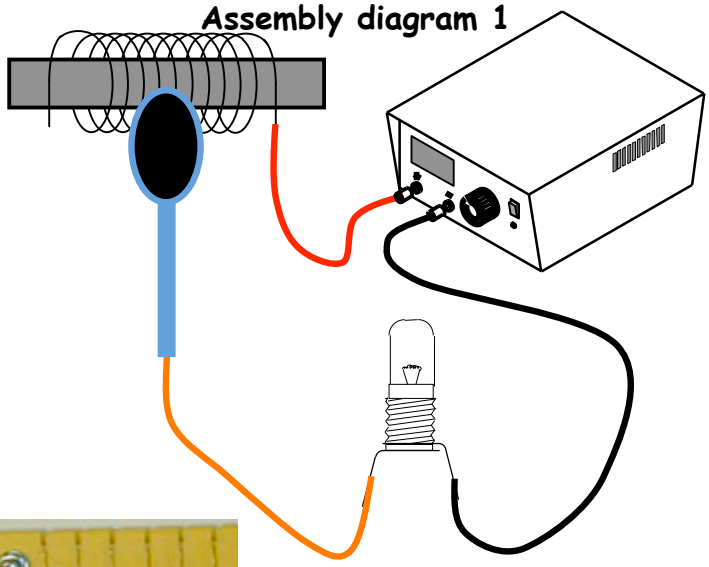
Variable resistor (directed laboratory)

Using a variable resistor (2 contacts)

Materials 1

- 1 power supply (10 volts)
- 3 alligator clip wires
- 1 small metal spoon
- 1 - **n° 1446** (non coloured) 12 volt incandescent light bulb
- 1 - 4 meter long roll of **n° 28** nichrome[1] wire (see annex for supplier). The support may be an 8 cm by 28 cm piece of styrene (see photo at right). The styrene is notched in such a way as to maintain the wire in place. The wire is rolled and affixed with screws at each end. These screws are used as connectors.

Assembly diagram 1



Observations (manipulation 1)
When we rub the spoon from one end to the other of the nichrome roll, the light intensity of the light bulb changes.

[1] Nickel chrome alloy used as a heating element.

Analysis of phenomenon 1

Question 1

In relation to the diagram, the light intensity is greater when the spoon touches the right side of the roll.

Question 2

The light intensity weakens when the spoon is moved to the left because the electrical current must then use a longer and longer route. Electrical conductivity diminishes when the length of the conductor is increased.

Question 3

If the roll had double the number of turns, the current in the circuit could be further limited when the spoon was moved to the left. In this case, the light intensity of the bulb would become weaker and weaker, possibly until it disappeared entirely.

Question 4

If the nichrome roll were replaced by a copper roll, it is possible that the phenomenon would no longer be visible to the naked eye. A multi-meter could, however, detect a weak variation in the intensity of the electrical current.

Using a variable resistor (3 contacts)

Materials 2

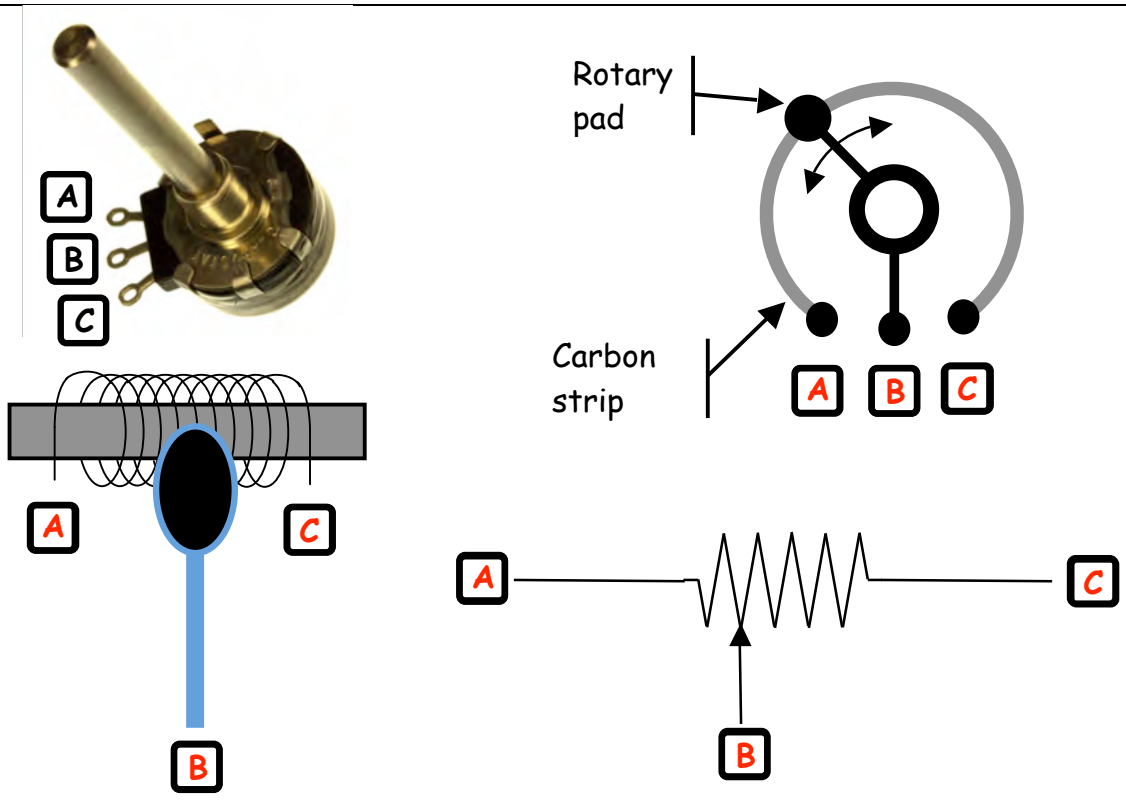
- 1 power supply (10 volts)
- 5 alligator clip wires
- 2 - **n° 1446** (non coloured) 12 volt incandescent light bulbs
- 1 - 4 meter long roll of n° 28 nichrome wire (see annex for supplier).
- 1 small metal spoon

Assembly diagram 2

Observations (manipulation 2)
When we move the spoon towards the left, the light intensity of the left hand bulb increases progressively, while the right hand one diminishes gradually. *When we move the spoon towards the right, the light intensity of the right hand bulb increases progressively, while the left hand one diminishes gradually.* *An interesting analogy can be made with the "fade" feature on a stereo.*

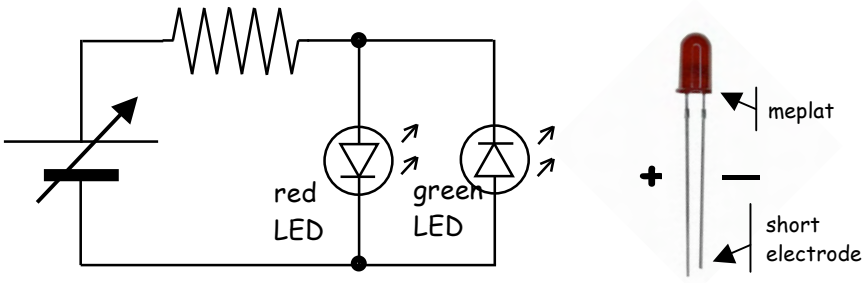
Analysis of phenomenon 2
Question 1 *At the point of contact between the spoon and the roll, the electrical current can take one of two routes to return to the source. Just as water around an island will pass in greater quantity around the side where it is easier, the electrical current will flow in greater quantity on the easier side. In our case, the easiest route is the side where the nichrome wire is shortest.*

Conclusion



Diode (directed laboratory)

Using a light emitting diode

Materials 1	Assembly diagram 1
• 1 (10 V) source • 1 resistor (≈ 250 Ω) **(variable power, ¼ or ½ watt for example)** • 5 alligator clip wires • 1 red LED • 1 green LED	

Observations (manipulation 1)

In the first configuration (on the diagram above) the red LED is lit and the green one is off. By reversing the polarity of the source, the red LED will be off and the green one will light up.

Analysis of phenomenon 1

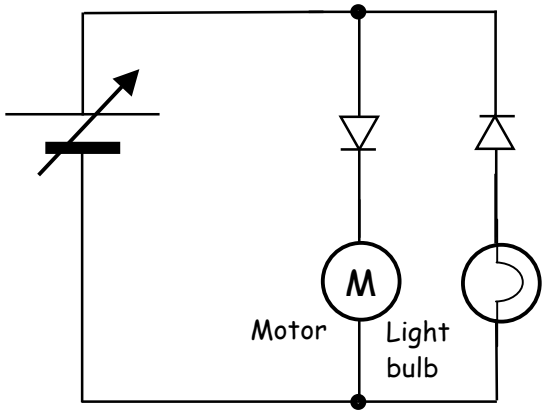
Question 1

The LEDs behave this way because they allow the current through only in one direction. The arrow in the LED symbol indicates the conventional direction of the current (from + to -).

Question 2

The negative electrode (cathode) of the diode recognises the meplat as well as the shorter length.

Using an ordinary diode

Materials 2	Assembly diagram 2
• 1 (10 V) source • 6 alligator clip wires • 2 ordinary diodes (Ex. : **1N4006**) • 1 electric motor (about 10 V) • 1 electric light bulb of about 10V, for example **(12 V n° 1446)**	

Observations (manipulation 2)

In the first configuration (configuration on assembly diagram 2) the motor will operate and the light is off. By reversing the polarity of the source, the light will be lit and the motor stops.

Analysis of phenomenon 2

Question 1

This circuit behaves essentially the same way as the previous circuit. It has a greater number of components, however, since there is a diode for each output component (motor and light bulb). The energy dissipated by the output components is also greater than in the case of the LEDs.

Conclusion (what is important to remember about diodes)

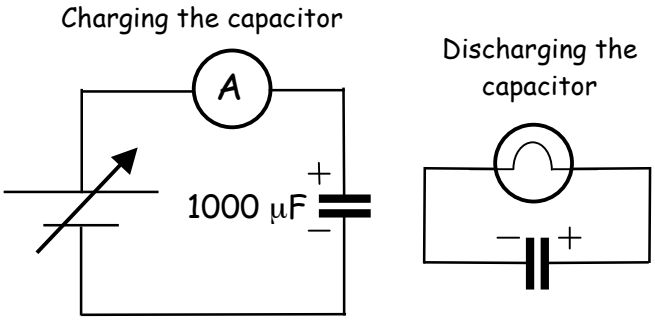
The diode only allows current through in a single direction.

The use of a diode allows the current to be switched in an electrical circuit.

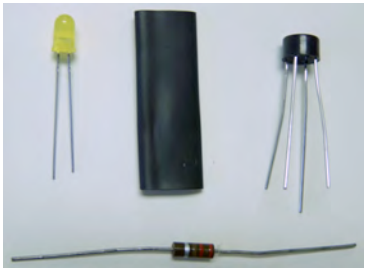
The LED is a diode that emits visible or invisible (ultraviolet, infrared) light.

Capacitor (directed laboratory)

Charge and discharge of a capacitor

Materials	Assembly diagram
• 1 variable supply • 1 ammeter (mV mode) • 3 alligator clip wires • 1 protected LED (see note below) or 1 incandescent light bulb (2V #233) • 1 electrolytic capacitor (≈ 1000 μF, minimum 12 V)	

***Note**: The #233 incandescent bulb works very well for this manipulation. Some students, however, may connect it directly to the supply at a much higher voltage than 2V, which the bulb will not be able to handle. In some classes, a large number of bulbs may need to be changed! Here is a way to avoid this problem.*



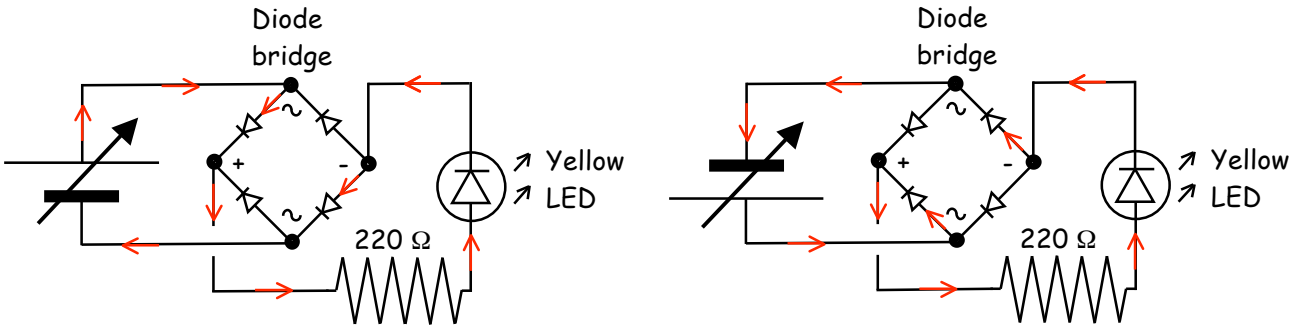
*The use of a set made up of a yellow LED, a heat-shrink casing, a diode bridge[2] and a resistor can effectively replace the bulb. This small circuit acts like the 2V bulb, but can support up to 12V. We will call this circuit the "**protected LED**".*

This protected LED is not polarised because of the use of the bridge. The student therefore does not have to worry about the polarity of the connection as is the case with an LED alone. The resistor is not used to limit the voltage going through the LED. A heat shrunk casing covers the whole thing, making it "student-proof".

The complete fabrication range for the protected LED is available in Annex 2 of this document.

[2] *A diode bridge is usually used to convert alternating current to direct current. In this case, other components are also used: capacitor, regulator*

To conclude, here are two circuits that show how the voltage circulates in the circuit, depending on the polarity of the supply.



Observations while charging
While charging the capacitor, the ammeter detects the passage of the charge from the source towards the capacitor plates. Once the capacitor is at the same potential as the source, the charges no longer move.

Observations while discharging
During discharge, the charges leave the plates where they were packed in order to be distributed onto the other plate. The current generated heats the filament of the bulb for a fraction of a second.

Analysis of the phenomenon

Question 1

While charging, the ammeter indicates the rate of charge that leaves the source to go accumulate onto the capacitor plates.

Question 2

The intensity of the current drops as soon as we stop increasing the source voltage, because the capacitor becomes charged and attains the same potential as the source. Wind always moves from a high pressure zone to a low pressure zone, just as electrical charges move from a high voltage zone to a low voltage zone. As soon as the voltage in the capacitor equals the source voltage, all movement of charges will cease. (I = 0 A).

Question 3

The voltage at the capacitor terminals is 10V after charging. This is equivalent to the source voltage.

Question 4

Since the light bulb only worked for a short time during discharge, we can affirm that the amount of charge stored by the capacitor is fairly weak.

Question 5

The charge and the discharge of a battery are much slower that those of a capacitor. The amount of charge accumulated, however, is greater in the case of the battery.

Conclusion (what is important to remember concerning capacitors)

The capacitor allows for the accumulation of electrical charges (electrons).

For a capacitor to be able to charge, the source must be at a higher voltage than the capacitor's terminals.

The amount of charge that it can accumulate is much smaller than a battery can accumulate.

It charges and discharges rapidly.

Solenoid (directed laboratory)

Using a relay

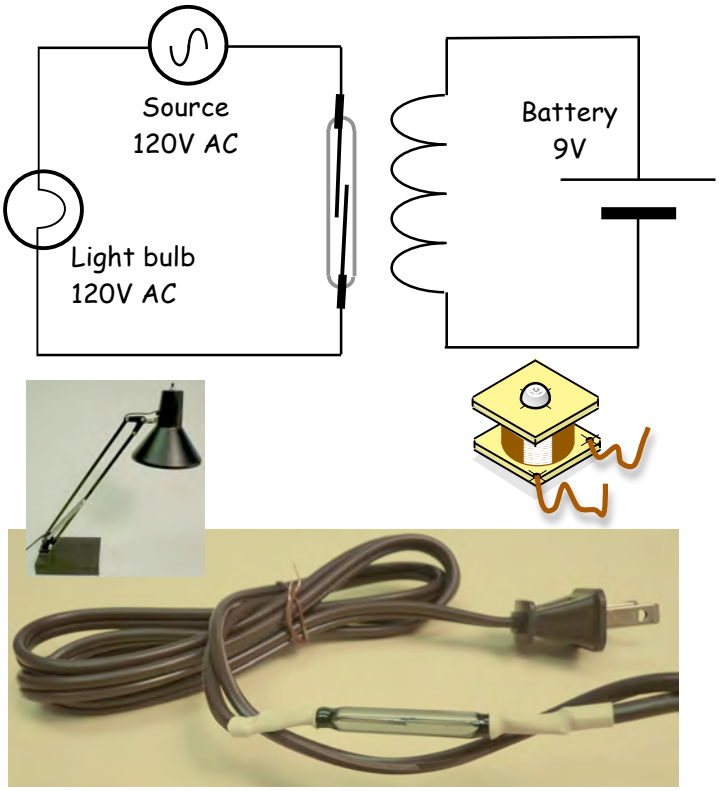
In this assembly, the choice of the variety of sources of current is deliberate (alternate and continuous current, low and high voltage). In the circuit below, the relay is used to "relay" the command. In this context, it unites totally different circuits. Beginning with a circuit made up of a small source of current (a 9V battery) and small conductors, we can command a much more robust circuit supplying devices with greater power.

Materials 1

- 1 - 120V assembly including
  - 1 - 120V AC current
  - 1 magnetic switch
  - 1 - 120V AC light bulb

  In fact what the assembly consists of is an extension, modified to include a magnetic switch (with plates) and a work lamp connected to the extension (see photos at right).
- 1 magnet
- 1 - 9V battery
- 1 electromagnet (from the RSM) **made from AWG 28 copper wire (see annex for supplier)**
- 2 alligator clip wires

Assembly diagram 1



Manipulation 1

(CAREFUL! 120 VOLTS) Check the 120V assembly in order to ensure that the magnetic switch is intact and there are no bare wires.

Observations (manipulation 1)

Initially, when the magnet is brought close to the magnetic switch, the switch closes and allows the current through to the high voltage (120V) circuit. At that moment, the current circulates through the light bulb which becomes hot and lights up.

Then, the magnetic field of the magnet is replaced by the field generated by the weak current circulating in the solenoid.

Analysis of phenomenon 1

Question 1

The voltage of the primary direct current circuit is 9V DC.

Question 2

$U = R \cdot I \rightarrow I = U / R$

Question 3

Presuming that the resistance of the body is 1000 Ω, here are the two calculations.

9V DC battery as source		**Area with 120V AC as source**	
Data	***Equation***	***Data***	***Equation***
$I = ?$	$I = U / R$	$I = ?$	$I = U / R$
$R = 1000\ \Omega$		$R = 1000\ \Omega$	
$U = 9V$		$U = 120V$	
Calculation	***Answer***	***Calculation***	***Answer***
$I = 9V / 1000\ \Omega$ or V/A	$I = 0.009\ A$	$I = 120V / 1000\ \Omega$ or V/A	$I = 0.12\ A$

The 120V voltage is more dangerous, since in generates a greater electrical current (0.12 A compared to 0.009 A), thus a greater output of charges. It is this strong intensity of current that heats the tissues in an electrocution.

Question 4

Wetting our fingers lowers the resistance of the body. The current thus penetrates more easily and is therefore greater. Let's redo the calculation for the 120V source and presume that the resistance has been reduced by 50% because of the presence of wet fingers.

$I = 120V / 1000\ \Omega$ or $V/A \rightarrow I = 0.12\ A$

$I = 120V / 500\ \Omega$ or $V/A \rightarrow I = 0.24\ A$

The intensity of the current is consequently doubled, therefore a greater amount of heat will be liberated, and greater danger.

Question 5

To support a strong intensity of current, such a switch must be strong, namely made up of big conductors. (The objective is that it conduct the current so well that the voltage at the terminals becomes almost nil).

Question 6

The main reason that a relay is used in the circuit to start a car or in the control circuit of an elevator is the same. Beginning with a low voltage circuit, made up of small conductors, we want to control a much bigger circuit, supplying devices like an elevator motor or a car starter. Imagine the size of the switches for these devices if this were not the case. We would see huge buttons on the elevator, and an enormous key for a car!!!

In addition, there is a security element in using a relay in these circuits. Since the power of the primary circuit is smaller, the risk for electrocution is lessened.

Conclusion 1 (what is important to remember about relays)

The relay is mainly used to relay the command between two circuits with different characteristics.

The relay also allows a higher powered circuit to be controlled from a circuit whose power is weaker.

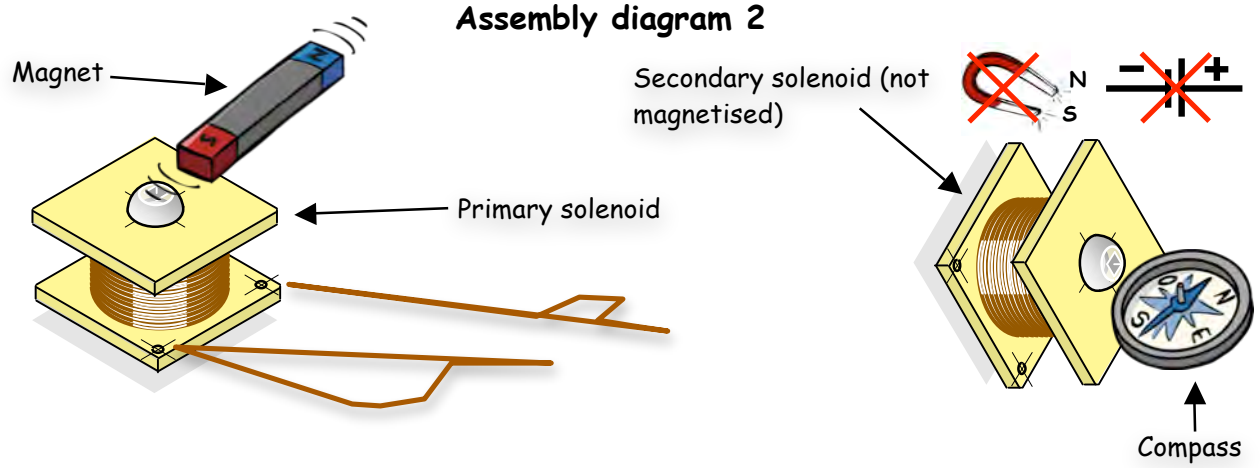
- *The use of a relay allows for the usage of a smaller control switch, and increases the safety of the user by reducing the risk of electrocution.*

Electromagnetic induction

Materials 2

- 2 solenoids made up of AWG28 copper wire (electromagnet from the RSM, see note below)
- 1 (rare earth) powerful magnet **(see annex for suppliers, they are torus shaped)**.
- 1 **small** compass **(about 15mm in diameter - they are more sensitive than bigger ones at close range)**
- 2 long (≈ 1 metre long) alligator clip wires (or 2 shorter alligator clips connected end to end)

Assembly diagram 2



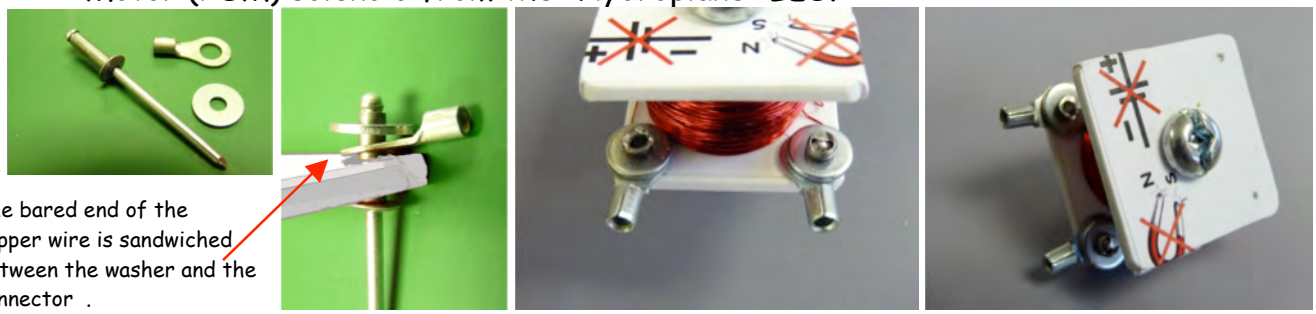
Observations 2a (when the magnet is shaken as close as possible to the primary)

The compass reacts by oscillating.

Observations 2b (when the magnet is immobile, as close as possible to the primary)

The magnet no longer moves.

Note: Here is how it is possible to add connection terminals onto the Reed switch Motor (RSM) solenoid from the "Hydroplane" LES.



The bared end of the copper wire is sandwiched between the washer and the connector .

Analysis of phenomenon 2

Question 1

The compass that reacts by oscillating tells us that a current is inducted in the secondary solenoid.

Question 2

No, the presence of a magnet immobile close to the primary magnet generates no current in the circuit. If there is no remnant in the core of the secondary solenoid, the compass will then point towards the magnetic north.

Question 3

To induce a current into our circuit, the magnet must be continuously shaken close to the primary solenoid. This is precisely what occurs inside an alternator with permanent magnets. The rotation of the rotor, made up of permanent magnets, constantly changes the configuration of the magnetic field (variable magnetic field).

Question 4

On assembly diagram 2, it is the primary solenoid that captures the variable magnetic field generated by the action of the magnet. Inside the gaussmeter, it is therefore the solenoid that will detect variable magnetic fields.

Question 5

No, the gaussmeter is incapable of detecting the magnetic field of an immobile magnet. In the same way, an immobile electromagnet supplied by direct current will not be detected. However, an immobile electromagnet supplied by alternating current will be detected, since it generates a variable magnetic field.

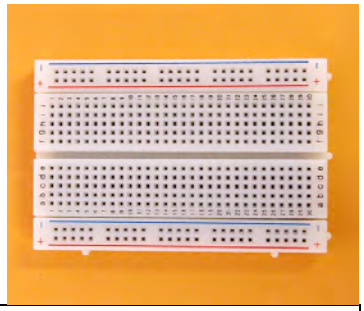
Conclusion 2 (what is important to remember about electromagnetic induction)

- *In order for there to be electromagnetic induction in the solenoid, the presence of a variable magnetic field is essential.*
- *It is the solenoid of the gaussmeter that will capture the variable magnetic field generated by electrical installations or devices.*

Transistor (directed laboratory)

Amplification of a transistor

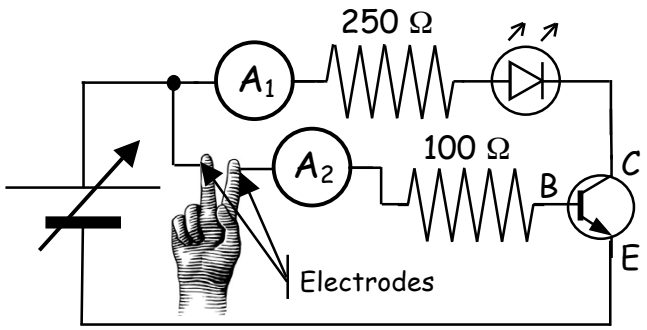
The circuit below is somewhat difficult to assemble using alligator clips. It would be possible to diminish the complexity by using an assembly panel like the one shown on the photo at right. To obtain one, consult the supplier list in the annex.

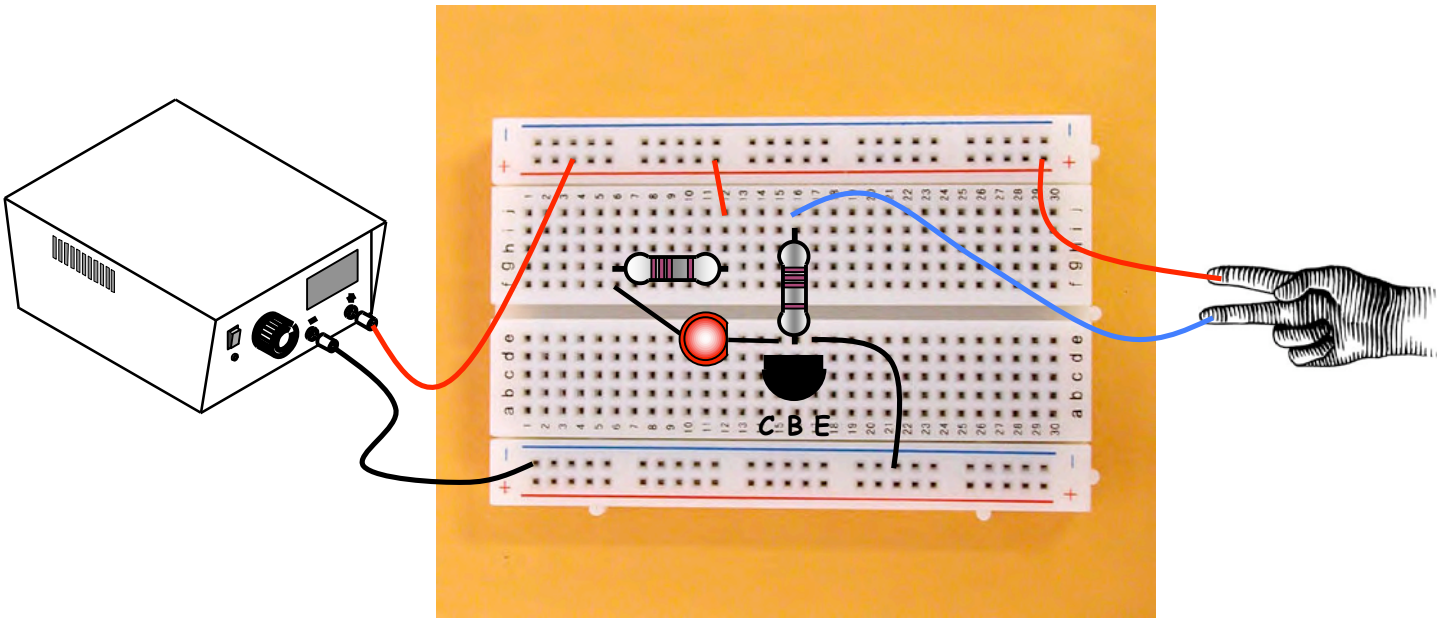


Materials

- 1 variable source of current
- 1 ammeter (mode: 20 mA)
- 1 NPN **(2N4401)** transistor
- 1 ≈250 Ω resistor
- 1 ≈100 Ω resistor
- 7 alligator clip wires
- 1 LED
- 1 damp hand

Assembly diagram





Data table	
Intensity of current of the ammeter in position «A_1» (ampere)	*E.g.: 0.161 mA*
Intensity of current of the ammeter in position «A_2» (ampere)	*E.g. 0.006 mA*

Analysis of the phenomenon

Question 1

The intensity of the current is greater when the ammeter is in position «A_1».

Question 2

Here is an example of a possible calculation.

Greater intensity / Lower intensity = A_1 / A_2 = 0.161 mA / 0.006 mA = 26.8

Question 3

The ratio calculated in the previous question corresponds to the amplification capacity of the transistor (gain in transistor, whose symbol is β). Concretely, the current passing through the collector (I_c) is about 27 times greater than the current passing through the base (I_c). ***The current going through your fingers is amplified 27 times.*** *($\beta = I_c / I_b$)*

Question 4

In the Gaussmeter's circuit, the transistor is used to amplify the signal detected by the solenoid. The amplified signal will then supply the LED, the buzzer and the voltmeter.

Conclusion (what is important to remember about transistors)

- *The transistor is an electronic component capable of amplifying the intensity of the electrical current (I).*
- *The amplification factor is called gain.*
- *A variable magnetic field induces a current in the solenoid. This current is then amplified by the transistor.*

Making the Gaussmeter's circuit

Cutting the circuit plates

Required equipment:

- Band saw equipped with a blade for metal (18 teeth per inch)
- Permanent marker
- Ruler
- $8\frac{1}{2}$ X 11 circuit plate
- Safety glasses
- Mask

How to proceed:

1. Install the metal cutting blade on the band saw.
2. Measure and divide the plate in order to obtain 18 sections.
3. Cut the plate with the band saw.
4. Sand the plates (if necessary).

Recommendations for cutting and sanding:

1. Close the "valve" connecting the saw to the dust catcher. Then purpose of this is to avoid the possibility of sparks enflaming the sawdust contained in the dust catcher.
2. If there is no valve, do not use the dust catcher while cutting and ensure that the room is well ventilated.
3. Wear a mask and wear safety glasses while cutting.
4. Use the same precautions if it is necessary to use the sander.

Note: Closing the "valve" on the saw and leaving the dust catcher in place allows for the room to be well ventilated through the other machine tools.

Preparing the solutions

Required equipment:

- Safety glasses
- Scale
- Weight vessel
- Spatula
- 1L graduated balloon
- 100 mL graduated cylinder
- Eye-dropper (or transfer pipette)
- 1000 mL beaker
- Agitating hot plate + magnet (magnetic bar)
- Distilled water

1. **"Developer" developing solution:**

   NaOH Aqueous solution

   (4 to 10 g of NaOH in 90 to 96 mL of distilled water)

   Recipe: 1 part concentrated solution into 10 parts distilled water

2. **Solution for engraving: sodium persulfate**

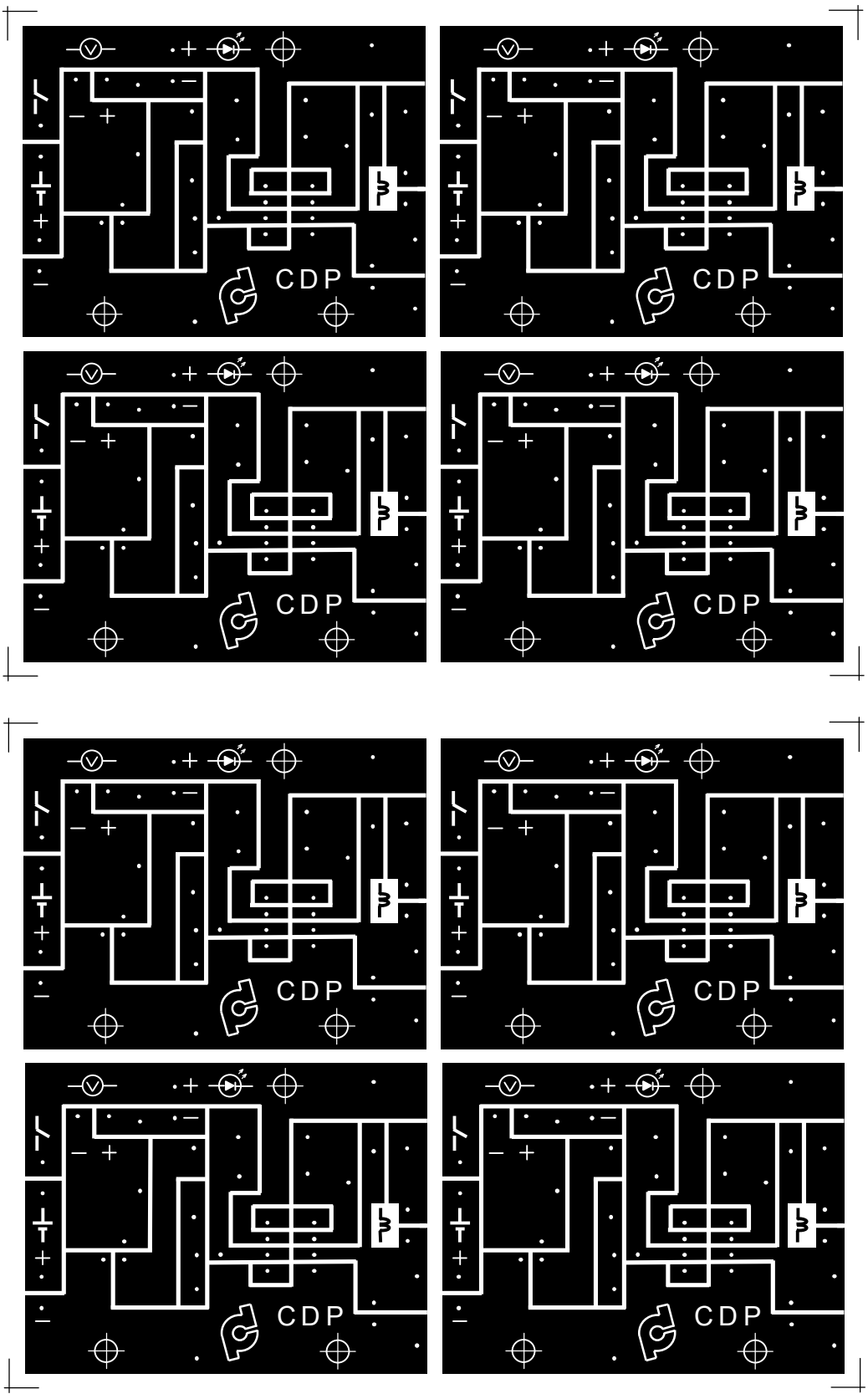
   Recipe: 250 g in 1000 mL of distilled water

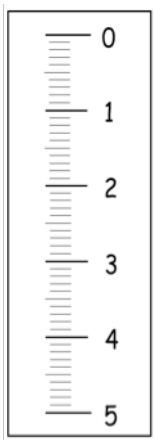
3. **Tinning: Liquid tin**

   Bought at an electronics supplier

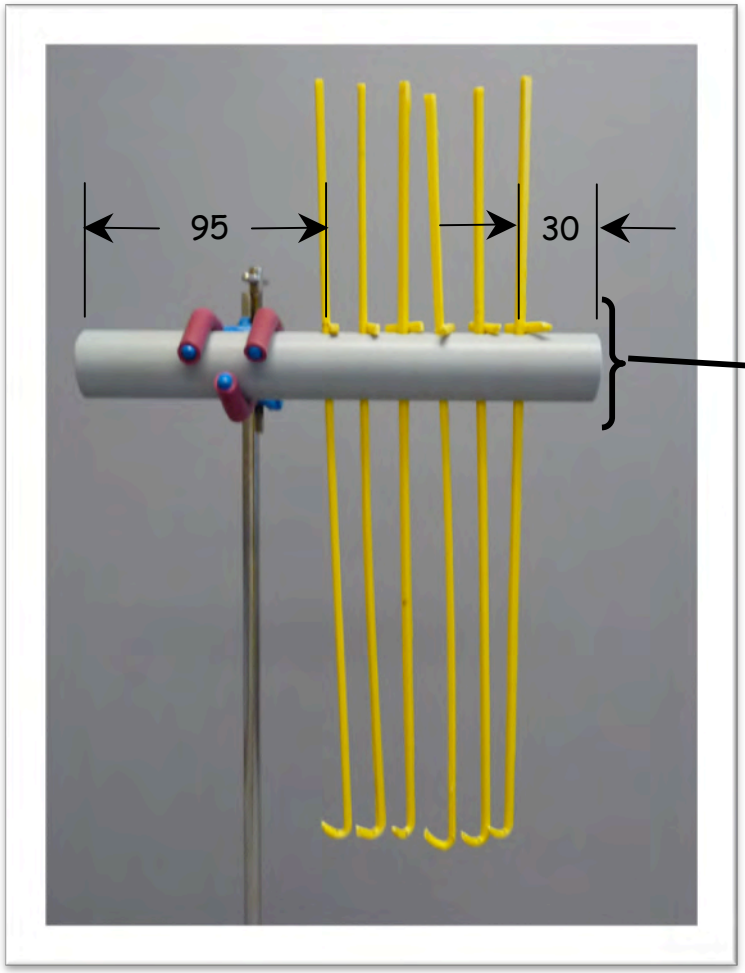
Mask for the Gaussmeter circuit plate

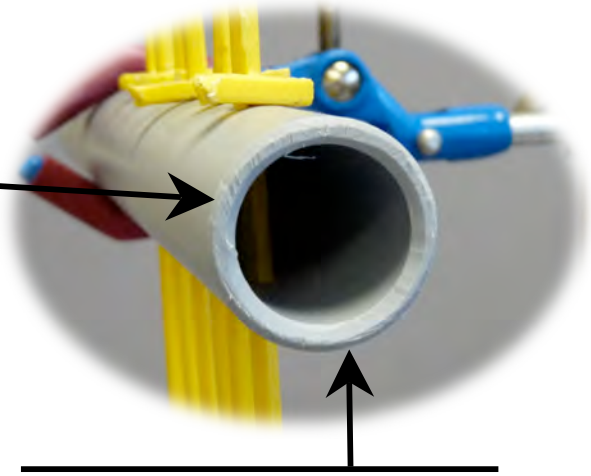
Ensure that this page is truly to scale after printing by measuring the ruler at right. When printing with "Acrobat Reader", it is important not to choose the option "print to scale" in the print menu.



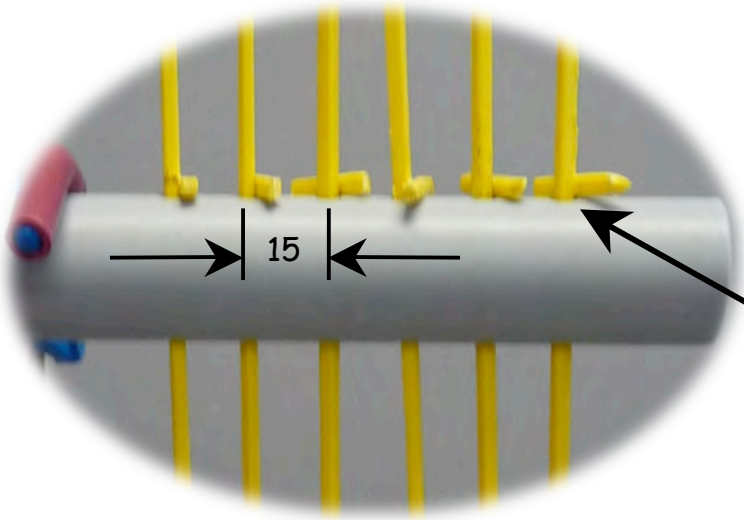


Assembling the plate supports for engraving



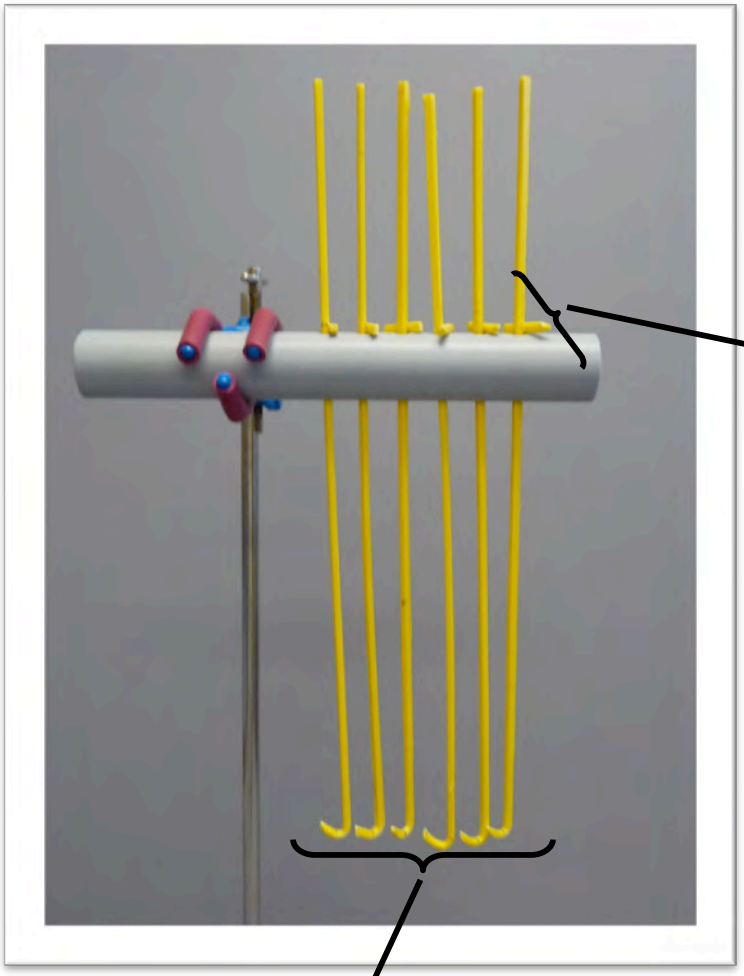


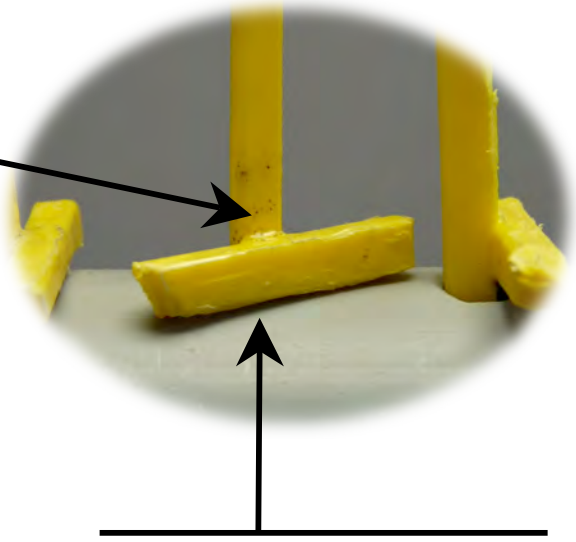
PVC pipe
Int. diameter 21 mm (3/4 in. int.)
200 mm long



Drill the pipe right through with a 5 mm (3/16" in.) hole

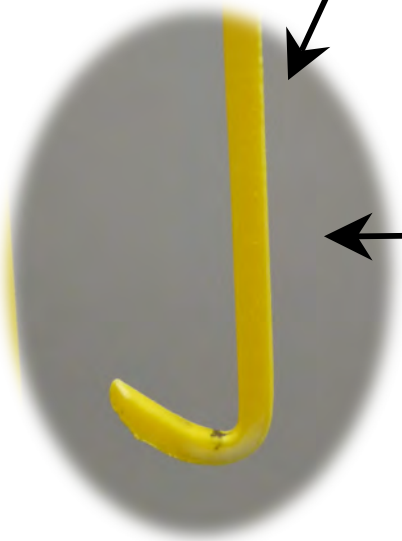
Drill 6 holes.





Cut some polystyrene pieces to about 15 mm. These pieces will be used as butt plates.

Glue the butt plates about 210 mm from the elbow part of the rod.



Polystyrene rod size:
350 mm X 3 mm X 3 mm

Bend the rod at 25 mm from the bottom end using the linear heating element.
The angle of the bend should be about 45°

Sand the end to make it thinner.

Trouble shooting while making the plate

Problem	Cause of the problem	Solving the problem
The plate develops poorly or not at all	1. Exposure time too short.	▪ Increase exposure time.
	2. Development time too short.	▪ Increase developer time.
	3. "Developer" solution past expiry date or saturated.	▪ Change the solution.
	4. Plate past expiry date.	▪ Change the plate lot.
Unfocused development	1. Dirty mask.	▪ Check the print quality from the printer.
		▪ Check the superimposition of the transparencies (acetates).
	2. Poor contact (space) between the mask and the plate.	▪ Improve the pressing.
		▪ Check that the mask is well affixed in the frame.
	3. Poor position of the UV lamp.	▪ Position the lamp in such a way that the UV rays hit the surface perpendicularly.
Circuit cut after engraving	1. Cut on the mask due to poor photocopy.	▪ Copy the mask on another photocopier.
		▪ Solder a bridge (piece of wire) on the plate to re-establish the conductivity of the circuit.
	2. Scraped photosensitive resin before the engraving stage.	▪ Solder a bridge (piece of wire) on the plate to re-establish the conductivity of the circuit.
Insulated borders too wide or conductive zone perforated after engraving	1. Mask insufficiently opaque.	▪ Control the opacity when printing.
		▪ Superimpose two masks to increase opacity.
	2. Exposure time too long.	▪ Diminish exposure time.
	3. Engraving time too long.	▪ Diminish engraving time.
Development adequate, but engraving insufficient	1. Engraving time too short.	▪ Increase engraving time.
	2. Saturated sodium persulfate.	▪ Change the solution.

(Source: *jacques.boudier.pagesperso-orange.fr/.../cours/cours_01.pdf)*

Metric equivalents to Imperial bits

No.	Imperial diameter (in.)	Imperial diameter in (mm)	Metric diameter (mm)
1	1/16"	1.59	1.5
2	5/64"	1.98	2
3	3/32"	2.38	2.5
4	7/64"	2.78	3
5	1/8"	3.18	3
6	9/64"	3.57	3.5
7	5/32"	3.97	4
8	11/64"	4.37	4.5
9	3/16"	4.76	5
10	13/64"	5.16	5
11	7/32"	5.56	5.5
12	15/64"	5.95	6
13	1/4"	6.35	6.5
14	9/32"	7.14	7
15	19/64"	7.54	7.5
16	5/16"	7.94	8
17	21/64"	8.33	8.5
18	11/32"	8.73	8.5
19	23/64"	9.13	9
20	3/8"	9.53	9.5
21	25/64"	9.92	10
22	13/32"	10.32	10.5
23	27/64"	10.72	11
24	7/16"	11.11	11
25	29/64"	11.51	11.5
26	15/32"	11.91	12
27	31/64"	12.30	12.5
28	1/2 "	12.70	12.5

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Safety capsules

(1) Lead, tin and other soldering





1. Watch out for burns that can be caused by the iron at more than 200°C. (Do not wear rubber or latex gloves, these substances could melt on your hands.)
2. Wear safety glasses to protect yourself from solder projections.
3. Use a soldering iron rest to avoid setting your clothing, hair, paper or plastic etc. on fire.
4. Do not shake the iron to clean it: use the sponge designed for the job.
5. Avoid touching the solder to your mouth or teeth - it is extremely toxic. (You must neither eat nor drink while soldering.)
6. Never solder components under tension.
7. Use in a well aired room or solder under the hood designed for this use in order to limit inhaling the vapours, since they are toxic.
8. Use a de-soldering bulb to remove a faulty solder.
9. Wash your hands after your work, and clean the work table to avoid any risk of intoxication.

Ensure that any modification to this capsule does not compromise student safety. Any person at fault will bear the consequences of his choices.





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Safety capsules

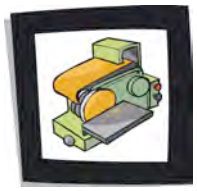
(7) Band saw

1. Wear safety glasses to protect against projections.
2. Tie long hair and roll your sleeves to avoid them becoming entangled in the mechanism.
3. Do not wear bracelets, necklaces, jewellery, etc.
4. Clean work surface of any debris that could lead to dangerous movements or that could hamper the proper operation of the saw.
5. Use a sharp blade since unnecessary effort could cause injury.
6. Take the time to think about each of your gestures. Keep your hands at least 5 cm away from the cut line.
7. Use a pusher for small parts in order to keep your hands far from the blade.
8. Respect the security perimeter on the floor. The proximity of another person could distract the user.
9. Use the dust hood or wear a dust mask.
10. Wear acoustic protection to avoid hearing problems if exposure to noise reaches 85 decibels for a period of 8 consecutive hours.

Ensure that any modification to this capsule does not compromise student safety. Any person at fault will bear the consequences of his choices.

Safety capsules

(8) Band and disk sander





1. Wear safety glasses to protect against projections.
2. Tie long hair and roll your sleeves to avoid them becoming entangled in the mechanism.
3. Do not wear bracelets, necklaces, jewellery, etc.
4. Clean work surface of any debris that could lead to dangerous movements or that could hamper the proper operation of the sander.
5. Take the time to think about each of your gestures.
6. Respect the security perimeter on the floor. The proximity of another person could distract the user.
7. It is mandatory that the dust hood be activated when using the band and disk sander. If there is a cancer-producing contaminant present (e.g. silica) the mask is also mandatory.
8. Call the laboratory technician if the band becomes misaligned.
9. Wear acoustic protection to avoid hearing problems if exposure to noise reaches 85 decibels for a period of 8 consecutive hours.




Ensure that any modification to this capsule does not compromise student safety. Any person at fault will bear the consequences of his choices.

Safety capsules

(9) Press drill

1. Wear safety glasses to protect against projections.
2. Tie long hair and roll your sleeves to avoid them becoming entangled around the chuck.
3. Do not wear bracelets, necklaces, jewellery, etc.
4. Careful! Risk of serious injury! Firmly affix materials to the table using clamps to avoid a part being hooked to the bit and spun around at great speeds.
5. Adjust the height and depth of the table and tidy the work surface before starting the drill.
6. Use a well sharpened bit, otherwise unnecessary effort could cause break the bit and cause injury.
7. Remove the chuck key immediately after having tightened the drilling tool.
8. Take the time to think about each of your gestures.
9. Respect the security perimeter on the floor. The proximity of another person could distract the user.
10. Unplug the tool from the power source before changing a bit.

Ensure that any modification to this capsule does not compromise student safety. Any person at fault will bear the consequences of his choices.

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Safety capsules

(10) Hot plate




1. Know where to find the first aid kit and safety equipment and learn how to use it (fireproof blanket, fire extinguisher, eye rinse, fire alarm, etc.)
2. Watch out for burns: the plate stays hot for quite a while.
3. Tie long hair and roll your sleeves to avoid them coming into contact with the hot plate and catching fire.
4. Wear safety glasses to protect against projections.
5. Wear protective clothing to guard against accidental projections.
6. Never direct the opening of a test tube towards yourself or someone else.
7. Use the appropriate tongs to manipulate laboratory glassware (beaker or test tube tongs etc.)
8. Take the time to think about each of your gestures.
9. Never use flammable substances close to a flame or hot plate.



Ensure that any modification to this capsule does not compromise student safety. Any person at fault will bear the consequences of his choices.

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Safety capsules

(12) Acid solutions





1. Careful! Acids are corrosive substances.
2. Wear safety glasses to protect against splashing. In case of contact with the eyes, rinse them immediately using the eye wash in the classroom.
3. Tie long hair and watch your sleeves to avoid any contact with the acid and to avoid spilling.
4. Never smell emanations directly. Direct the vapours towards your nose with your fingers.
5. Wear protective clothing in case of accidental projections.
6. In case of contact with your skin, wash it off with water and always wash your hands at the end of manipulations.
7. Take the time to think about each of your gestures.
8. Clean the work surface after manipulations to pick up any possible spillage.

Ensure that any modification to this capsule does not compromise student safety. Any person at fault will bear the consequences of his choices.





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Safety capsules

(13) Basic solutions





1. Careful! Basic solutions are corrosive substances.
2. Wear safety glasses to protect against splashing. In case of contact with the eyes, rinse them immediately using the eye wash in the classroom.
3. Tie long hair and watch your sleeves to avoid any contact with the base and to avoid spilling.
4. Never smell emanations directly. Direct the vapours towards your nose with your fingers.
5. Wear protective clothing in case of accidental projections.
6. In case of contact with your skin, wash it off with water and always wash your hands at the end of manipulations.
7. Take the time to think about each of your gestures.
8. Clean the work surface after manipulations to pick up any possible spillage.

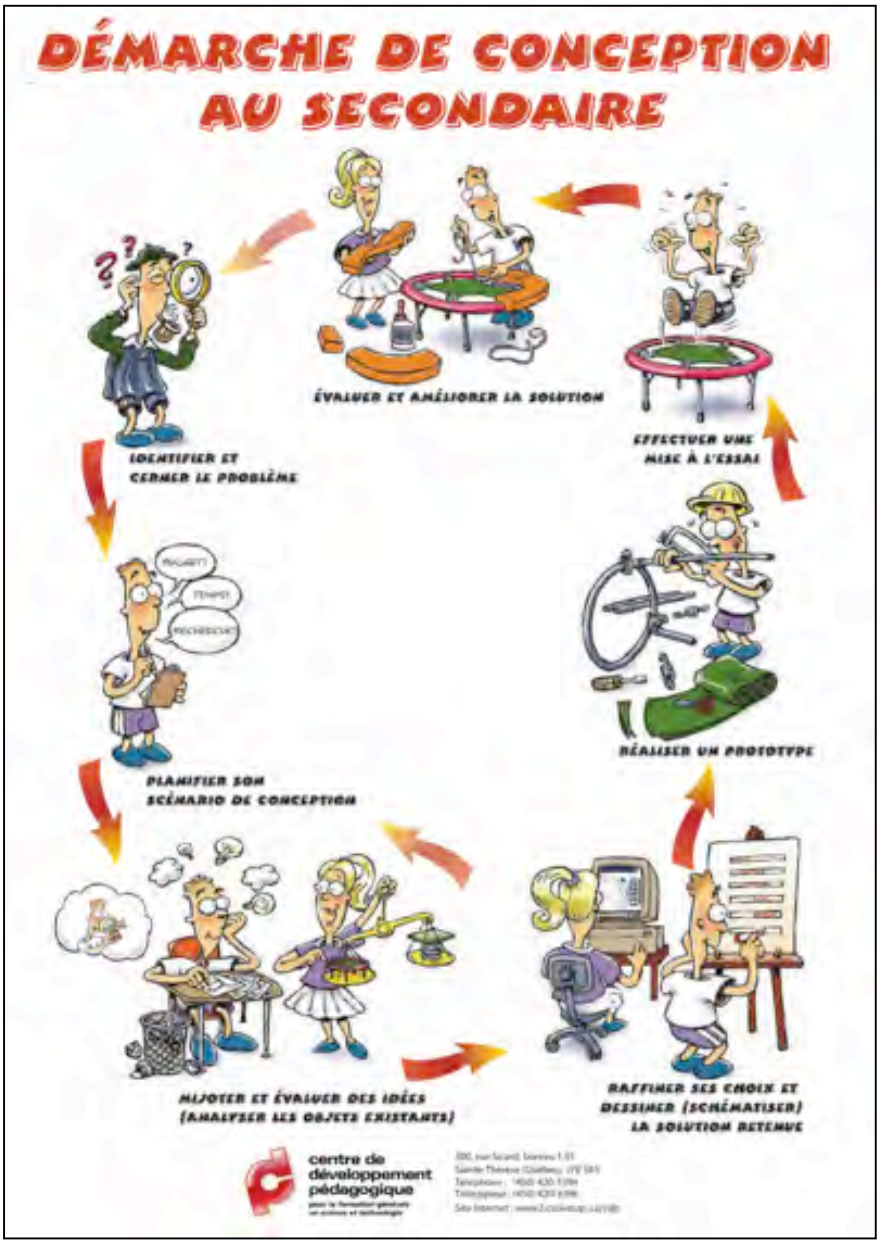
Ensure that any modification to this capsule does not compromise student safety. Any person at fault will bear the consequences of his choices.





Designing the Gaussmeter housing

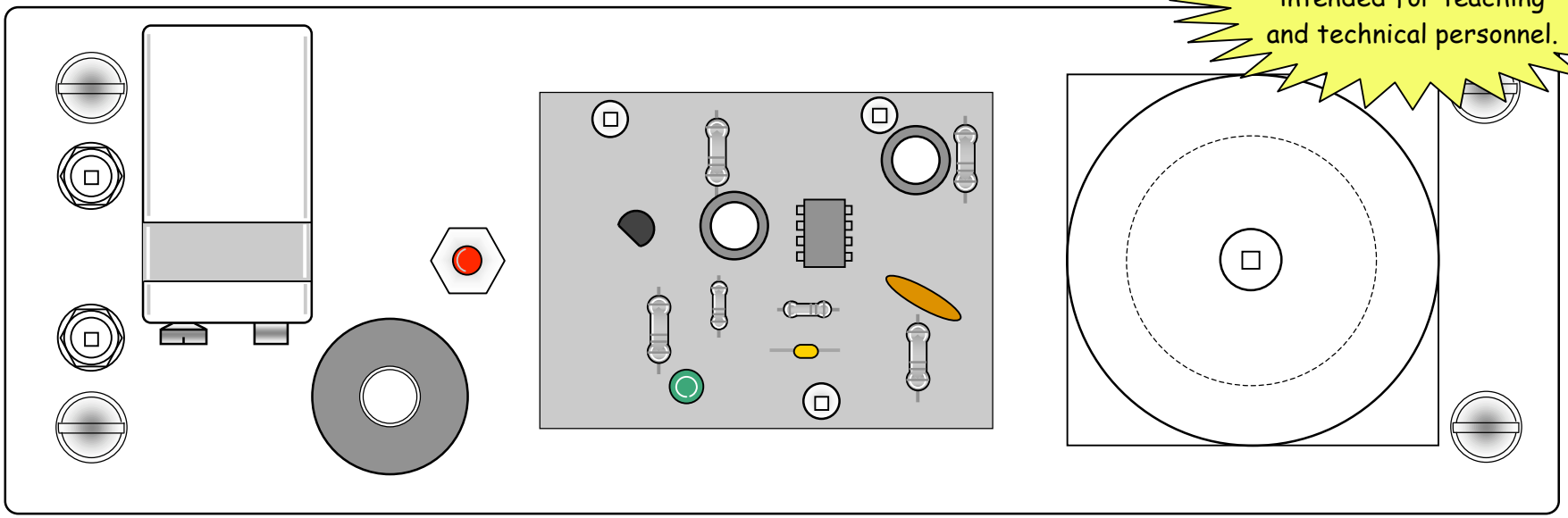
Even though a basic housing is suggested for training teaching and technical personnel, it is not our intention to have the students make this housing. In our opinion, it is important to give the student room for the creativity of making his/her own housing.

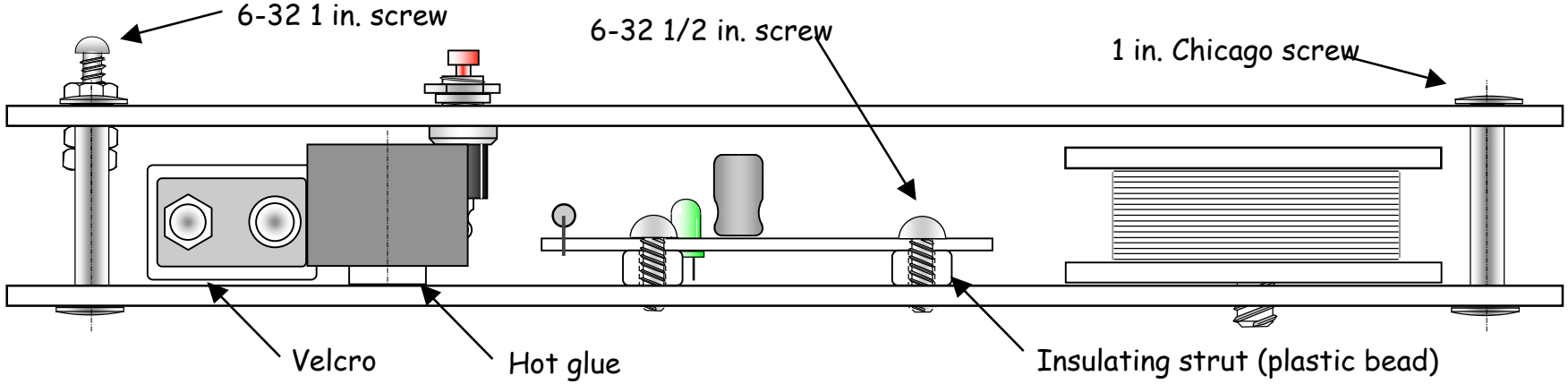


Given its complexity, it is not realistic to have the student design his/her own circuit. Allowing the student free rein to design a great housing perfectly adapted to the components of the circuit is, however, perfectly within their abilities. **The drawings on the following pages are therefore not intended for the students.** They are solely there to accelerate training for teaching and technical personnel.

It would be a shame to pass up this opportunity to experience a simple design process that gives rise to the possibility of using the machine tools available in fourth year.

This drawing is intended for teaching and technical personnel.





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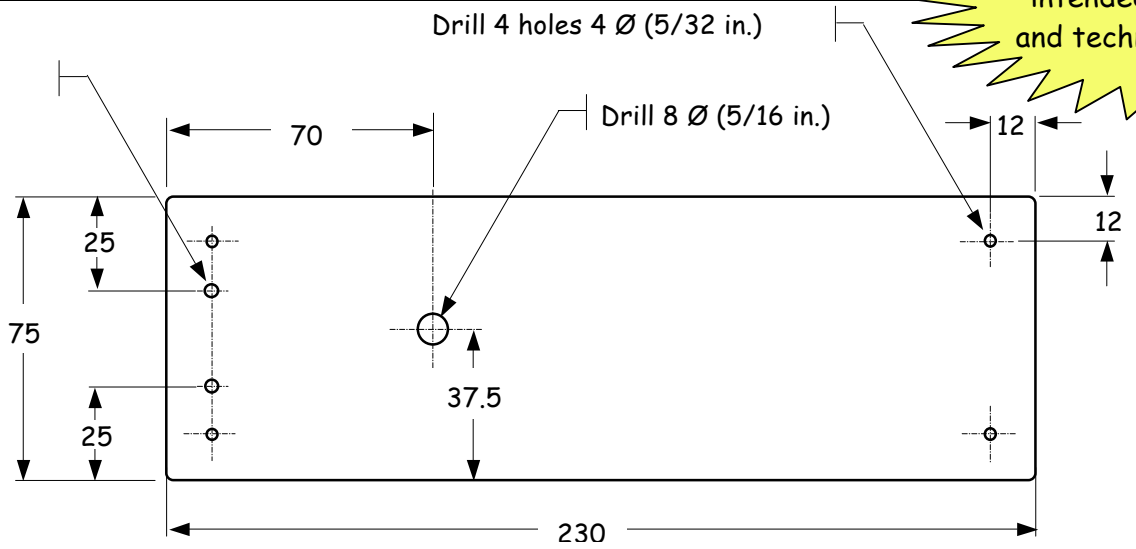
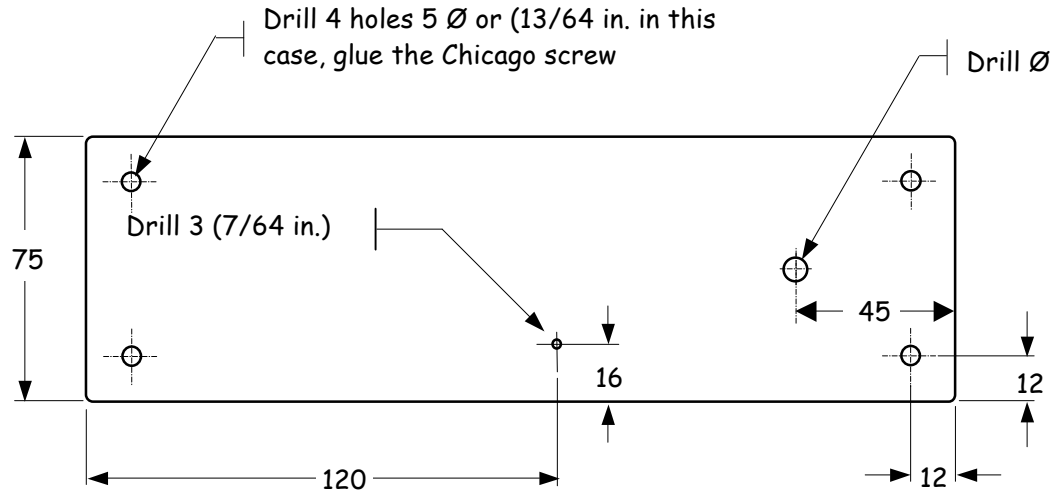
ACTIVITY: « Gaussbusters » LES		
NAME: Set drawing of the Gaussmeter (housing used for training teaching and technical personnel)		
DATE : May 2, 2011	SCALE: **1 = 1**	DRAWING: **N° 4**

This drawing is intended for teaching and technical personnel.

PROTECTION PLATE



SUPPORT PLATE



centre de développement pédagogique *pour la formation générale en science et technologie*	ACTIVITY: « Gaussbusters » LES		
	NAME: Detail drawings of the plates for the Gaussmeter housing (for personnel training)		
	DATE: May 2, 2011	SCALE: Not determined	DRAWING : **N° 5**

Webography

Making a printed circuit

http://jeanmoulin-thouars.fr/site/LMB-La-fabrication-du-circuit.html

http://www.youtube.com/watch?v=Jdn1ndJBY1s&feature=BF&list=PLD793ECD925206C9F&index=13

http://www.youtube.com/watch?v=r6z_Zz4MD5c&feature=related

Making an integrated circuit on a silicon wafer:
http://www.youtube.com/watch?v=BsOIgXQQTSo&feature=BF&list=PLD793ECD925206C9F&index=4

http://www.youtube.com/watch?v=LWfCqpJzJYM&feature=BF&list=PLD793ECD925206C9F&index=6

Tips: Tin soldering
http://www.interface-z.com/conseils/soudure4.htm

Tutorial about soldering
http://www.sonelec-musique.com/electronique_bases_tutoriel_soudure.html

Video about soldering two wires
http://www.youtube.com/watch?v=Q-nYfRoryFI

Video about tin soldering on a printed circuit
http://www.youtube.com/watch?v=xRfFjJqo3iA

Video about how to use a de-soldering braid
http://www.youtube.com/watch?v=AcbezX8TrOU

Video about how to use a de-soldering pump
http://www.youtube.com/watch?v=Aw4lZGk90i4

Annex 1 (suppliers)

N. B. The following equipment and materials are available elsewhere, these suppliers are used as examples.

¾ inch rare Earth magnets (n° 99K37.04)

Lee Valley Tools Ltd.

http://www.leevalley.com/en/hardware/page.aspx?p=40075&cat=3,42363,42348&ap=2

P.O. Box 6295, Station J
Ottawa, ON K2A 1T4
Tel : (613) 596-9202
Fax: (613) 596-9502

AWG 28 Nichrome wire, enamelled copper wire (varnished AWG 28

Prolabec

http://www.prolabscientific.com/Fil-de-Nickel-Chrome-p-22779.html

http://www.prolabscientific.com/Fil-de-Cuivre-Monobrin-Emaille-p-22778.html

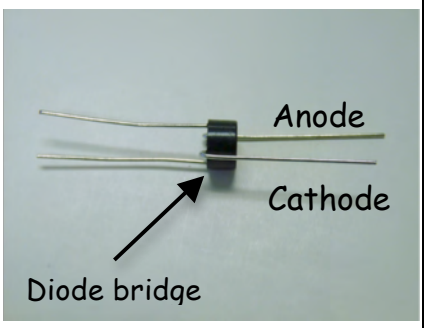
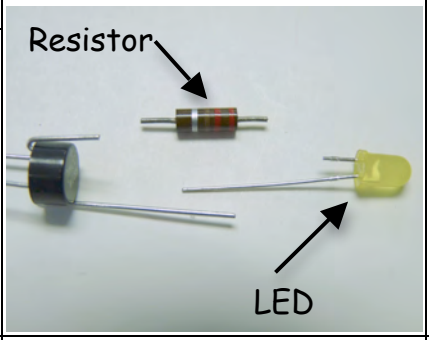
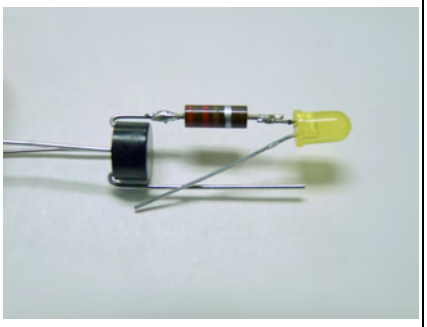
2213, le Chatelier Street
Laval (Quebec) H7L 5B3
CANADA
Telephone: (450) 682-5118 or (800) 556-5226
Fax: (450) 682-6468 or (800) 556-8182

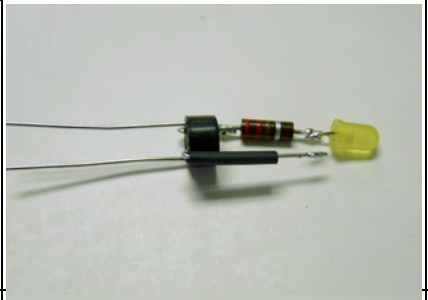
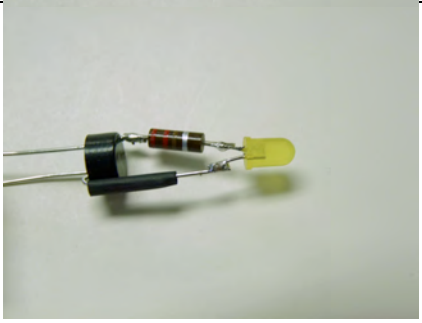
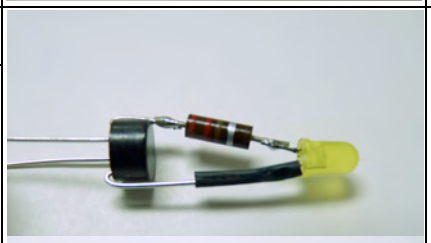
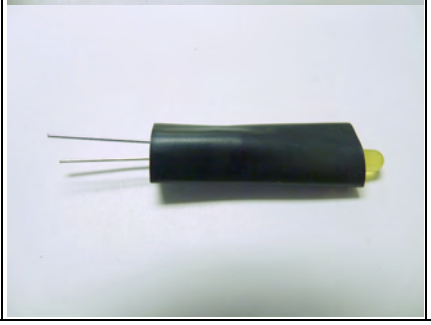
Assembly panel for circuit simulation (438-1109-ND)

Digi-Key

http://search.digikey.com/scripts/DkSearch/dksus.dll?lang=en&site=US&KeyWords=438-1109-ND&x=15&y=15

Annex 2 (protected LED)

FABRICATION AND ASSEMBLY RANGE			
ELEMENT: **PROTECTED LED**			
ACTIVITY: **«Gaussbusters» LES** (Learning activity: the capacitor)			
N°	**PHASE, SUB-PHASE OR OPERATION**	**PHOTO OR DRAWING**	**PARTS, TOOLS**
10	**FOLDING**		
11	Fold the cathode (-) and the anode (+) on the diode bridge in directions opposite from the entry electrodes (alternating current) **Note**: Any cylindrically shaped diode bridge will do the trick.		- Diode bridge (diameter ≈ 9 mm) (W01GDI-ND $0.45)
20	**ADJUSTMENT**		
21	Using wire cutters, cut the anodes from the bridge and the LED to a length of ≈5 mm.		- Resistor (220 Ω, ½ watt) (220H-ND $0.13) - Yellow LED (5 mm, 2.1 V) (754-1284-ND $0.12) - Wire cutters
22	Using wire cutters, cut the resistor electrodes to a length of ≈5 mm.		
30	**SOLDERING**		
31	Using a soldering iron and flux, solder one of the resistor electrodes to the anode of the bridge.		- Soldering iron - Flux
32	Using a soldering iron and flux, solder the free electrode of the resistor to the anode of the LED.		

40	**ADJUSTMENT**		
41 42 43	Using wire cutters, cut the cathode of the LED to a length of ≈5 mm. Also cut off the excess of the bridge cathode. Insert 15 mm of a heat shrink casing onto the cathode.		- Heat shrink casing (2 mm diameter) - Wire cutters
50	**SOLDERING**		
51	À l'aide d'un fer à souder et d'étain, souder ensemble les cathodes du pont et de la DEL.		- Soldering iron - Flux
60	**HEATING**		
61 62 63	Move the heat shrink casing onto the solder to be protected. Using a heat gun, heat the casing on the cathode until it shrinks to fit the solder perfectly. Using a heat gun, heat the main heat shrink casing until it fits the whole assembly perfectly.	 	- Heat shrink casing (10 mm diameter) - Heat gun