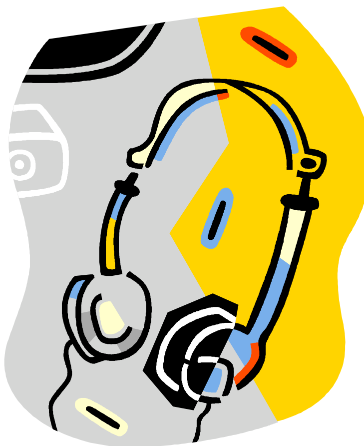
centre de développement pédagogique
pour la formation générale en science et technologie

EARPHONES



TEACHER'S GUIDE

October 2007

WORKING DOCUMENT

IMPORTANT NOTES

1. Before starting to read this guide, I invite you to read the overview of the task. Indeed, the overview will allow you to better situate this LES within the program. A glimpse of the student booklet appears to the right of the pages of this document.
2. This learning situation has been designed especially for the applied science and technology (AST) course.
3. You will find an evaluation grid for this LES in **annex 1** of this guide.
4. Five periods are foreseen for this LES:
   - Periods 1, 2 and 3: complete the observation cards and review in plenary session.
   - Period 4: complete analysis card, principles diagram and explanations of functionality.
   - Period 5: study of anomalies and reflection.
5. The number of students per team has been set at four in order to limit the number of stations. It is very difficult to find more than eight anomalies in an earphone's function. In addition, a greater number of stations (2 X 8 stations) makes managing the lab very cumbersome.
6. Practically, **3 other documents** will help you to prepare your operation.
   - A manufacturing range will help you make 9 sets of earphones (one perfectly functional and 8 others containing anomalies).
   - A list and pictures of the materials required to bring to term the manipulations associated to the theoretical notions observations cards.
   - A short « PowerPoint » presentation that may be used in the fourth period. It presents pictures of different parts of a functioning set of earphones. It can be played continuously on a projector.
7. In **annex 2**, you will find a list of suppliers for the more specialised materials.

Context

Like many youths of your age, you have found a student job. You work evenings in an electronics store. Sometimes, clients bring back their defective earphones and ask for them to be repaired. Today, your boss has assigned you the task of repairing some of them.

You must understand the functioning principles of earphones to be able to find out what is defective.

Mandate

Each team must:

1. Find several defects in the earphones. Set forth the strategies used and imagine a way to repair them.
2. Familiarise yourself with the theoretical notions involved.
3. Determine the function of each of the components of the earphones.
4. Set forth the functioning principles of the earphones (principles diagram and explanation of the function).

How must you go about finding the defects in the earphones? What has to be done?

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IMPORTANT NOTES (CONTINUED)

The theoretical notions seen here can be approached in many ways. Each teacher will bring his own methodology to the matter. In addition, the materials available in each institution may differ substantially. We nonetheless propose a way to work – it is up to you to decide.

- In the fourth year of high school some latitude must be left to the student. That is why the student is not guided much by the LES itself. The teacher's presence is primordial. He must move from station to station to share his knowledge and know-how. Without his presence, the students may become stymied and get discouraged. Different reference texts should also be available (for instance old physical sciences or I.T.T. books). It is even possible to supply each station with a card resuming the targeted theoretical notions (photocopies, for example). The student would then only need to select the useful information.
- The material necessary for each station is specified in the student booklet. In addition, the PowerPoint presentation called "Earphones theory materials" presents, by means of pictures, a detailed list of materials to use.

Suggested timetable for the observation cards.

Period 1 --> Introduction and 3 stations

Period 2 --> 4 stations

Period 3 --> 1 station and plenary session (teacher lecture)

STATION 1

Here, the student must check the conductivity of several samples through contact. They can proceed directly with the help of a multi-meter in «conduction» mode, or by connecting the sample in series in a circuit composed of a power source and a light bulb.

Instructions

1. Form teams of 4 people.
2. Go to the work station designated by the teacher.
3. At this station, the team must become familiar with the theoretical notions by means of the section called "**Theoretical notions observation card**".
4. The team must then go to the next work station in order to be faced with new theoretical notions (each team will have to work through all 8 stations set up in the lab).
5. When all the teams have finished their observations, a set of earphones will be placed at each workstation. You must then analyse these earphones by means of the section called "**Components analysis card**".
6. Next, you must complete the section called "**Principles diagram and explanation of functionality**".
7. The team must next locate the defect in the earphones at this station by completing the table called "**Study of anomalies**".
8. Finally, the team will move to the next station to be faced with a different set of defective earphones (each team will work through all 8 stations set up in the lab).

THEORICAL NOTIONS OBSERVATIONS CARD

Station #	Notions	Materiel
1	Objective: Differentiate between insulators and conductors Track: Through which substances do electrical currents travel?	*1 multi-metre (optional) * 1 battery (9 V) * 1 battery connector (9 V) * 2 wires * 1 light bulb (9 V) * 15 samples (see below)
	Samples 1. 1 nut - [illegible]" diameter 2. 1 nut - [illegible]" diameter 3. 1 piece of hot glue 4. 1 strand of tin for soldering 5. 1 electrical wire - 2 strand 6. 1 strand #32 non varnished copper wire 7. 1 strand #32 varnished copper wire	8. 1 magnet - [illegible]" diameter 9. 1 audio connector 10. 1 washer - 10mm diameter 11. 1 washer - 13 mm diameter 12. 1 #6 screw with milled head ([illegible]" long) 13. 1 #6 screw with round head ([illegible]" long) 14. 1 piece of cardboard - .85mm thick 15. 1 «Heinz» baby food jar
My observations about theoretical notions (what I need to remember)		

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STATION 2

At this station, the student must check the conductivity by introducing different samples into the circuit. While measuring the current by means of an ammeter, the student will determine the conductivity of the samples.

STATION 3

During these manipulations, the student must:

- Determine the configuration of the magnetic field by sprinkling iron filaments on the cardboard, being careful to place the magnet under it.
- Find the direction of the magnetic field with the help of the compass.
- Identify the north and south poles of the magnet with the compass.

Here the magnet must be fairly sizable in order to generate a good sized pattern in the iron filaments.

Station #	Notions	Material
2	Objective: Identify the factors that influence the conductibility of a conductor. Track: Through which samples does the current pass best?	* 1 «D» battery (1,5 V) * battery holder * 3 wires * 1 ammeter * 3 samples of different material (steel, copper, nickel-chromium) * 3 samples of different length (10, 50, 100 cm) * 3 samples of different size (#26, #22, #18)
My observations about theoretical notions (what I need to remember)		

Station #	Notions	Materiel
3	Objective: To determine the configuration and the direction of the magnetic field of a permanent magnet. Tracks: Do not put the filaments directly on the magnet. The coloured side of the needle of the compass is a north pole. How is the compass pointed close to the magnet? Where is the north pole of the magnet? How are the filaments positioned over the magnet?	* 1 straight magnet * 1 compass * 1 «salt shaker» for iron filaments * 1 piece of cardboard to hold the filaments
My observations about theoretical notions (what I need to remember)		

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STATION 4

During these manipulations, the student must:

- Determine the configuration of the magnetic field by sprinkling iron filaments on the cardboard, being careful to place the magnets under it.
- Find the direction of the magnetic field with the help of the compass.
- Identify the north and south poles of the magnet with the compass.
- Identify the forces involved (attraction and repulsion)

Here, the student should place the magnets side by side. The student must also study what happens between the two magnets (when there is repulsion and attraction).

STATION 5

During these manipulations, the student must:

- With a compass, detect the magnetic field around a straight wire through which an electrical current is running.
- Also to be observed by means of the compass is the direction of the magnetic field. A small diameter compass (about 2 cm) is preferable, since these small compasses are more sensitive and will react to weak magnetic fields better.

Even if in this case there is no north pole, we ask that the student try to find it. Eventually, he should understand that, in this case, a magnetic field may be detected without being able to identify the poles. The right hand rule may be approached with the students. As this notion may be difficult to understand, it may be presented in the third period lecture.

Station #	Notions	Materiel
4	Objective: Study the magnetic field and the forces generated by two permanent magnets. Tracks: Do not put the filaments directly on the magnet. The coloured side of the needle of the compass is a north pole. How is the compass pointed close to the magnets? At what point does a force of repulsion appear? How are the filaments positioned over the magnet?	• 2 straight magnets • 1 compass • 1 «salt shaker» for iron filaments • 1 piece of cardboard to hold the filaments
My observations about theoretical notions (what I need to remember)		

Station #	Notions	Materiel
5	Objective: To verify the presence and the direction of a magnetic field close to a straight wire with current travelling through it. Tracks: Is a compass influenced by a wire with current travelling through it? If so, where does the compass point close to this conductor? Where is the north pole?	• 1 power source (≈5 A) • 2 electrical wires • 1 copper conductor (#14) • 1 compass – small diameter (2 cm) – it is more sensitive
My observations about theoretical notions (what I need to remember)		

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STATION 6

During these manipulations, the student must:

- With a compass, detect the magnetic field around a solenoid through which an electrical current is running
- With a compass, observe the direction and poles of the magnetic field.

The right hand rule may be approached with the students. As this notion may be difficult to understand, it may be presented in the third period lecture.

STATION 7

During these manipulations, the student must:

- Verify the effect of the core of a solenoid by trying to attract the greatest number of paper clips from the box.

During this experiment, the tension may be set at the maximum for the power source (for example 10 volts).

Station #	Notions	Materiel
6	Objective: Study the field and magnetic poles generated by an electrical current traveling through a solenoid. Tracks: Where does the compass point close to the solenoid? Where is the north pole? What does the magnetic field of a solenoid look like?	• 1 power source (≠5 A) • 2 electrical wires • 1 copper solenoid • 1 compass
My observations about theoretical notions (what I need to remember)		

Station #	Notions	Materiel
7	Objective: Determine the effect of the nature of the core on the solenoid's magnetic field. Tracks: Adjust the power source to maximum and connect the solenoid. How many paper clips can be attracted by the solenoid into which you have placed the copper core?	• 1 power source (≠5 A) • 2 electrical wires • 1 polished #28 Cu solenoid (150 whorls) • 1 box of paper clips • 6 cores (iron, copper, aluminium, wood…)
My observations about theoretical notions (what I need to remember)		

STATION 8

During these manipulations, the student must:

- Verify the effect of a variable number of whorls on the number of paper clips attracted.

Here, a soft iron core must be used for each solenoid. The current must remain constant throughout the experiment (2A, for example).

PLENERY SESSION

Now is the time to have a plenary session concerning the theoretical notions discussed. Comprehension of these notions must be ascertained. Without a thorough grasp of the theoretical notions, the students will have difficulty proceeding with the rest of the project. A lecture is even recommended to explain the more complex notions (the right hand rule, for instance).

Station #	Notions	Materiel
8	Objective: Determine the effect of a variation in the number of whorls on a magnetic field of a solenoid. Tracks: Insert the iron core into the solenoid. Adjust the current to 2 amperes for each solenoid. How many paper clips can each solenoid attract?	* 1 power source * 1 ammeter * 1 soft iron core * 1 box of paper clips * 3 electrical wires * 1 #28 Cu solenoid with 150 whorls * 1 #28 Cu solenoid with 100 whorls * 1 #28 Cu solenoid with 50 whorls
My observations about theoretical notions (what I need to remember)		

How will the theoretical notions you have just explored help you to analyse the earphones and determine their defects?

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IMPORTANT NOTES

It would be preferable not to allow the consultation of documentary sources at the beginning of this activity. As the structure of our earphones is different from those presented in the literature, these sources may hinder the student's research. His previous knowledge as well as the study of the preceding theoretical notions should allow him to complete a good part of the analysis card. A consultation of the documentary sources could be allowed afterwards to complete the work. A short looped "PowerPoint" presentation may be used at this stage. It presents pictures of a functional set of earphones.

Completed analysis card

#	Components	Functions
1	1/8 connector	• Allows the reader and earphones to be electrically connected.
2	Wire	• Conducts the electrical signal moving the sound towards the earphones.
3	Casing	• Protects the earphones (wire, magnet…) • Acts as a sound board
4	Cover (membrane)	• Vibrates to generate sounds • Allows sound to escape by the holes
5	Magnet stand	• Keeps the magnet close to the solenoid's magnetic field.
6	Permanent magnet	• Generates a magnetic field close to the solenoid.
7	Solenoid or bobbin	• Generates a variable magnetic field in relation to the intensity and the direction of the current. • The solenoid can be attracted or repelled by the magnet and thus, vibrates.

COMPONENTS ANALYSIS CARD

#	Components	Function of components (concepts, models, theories)

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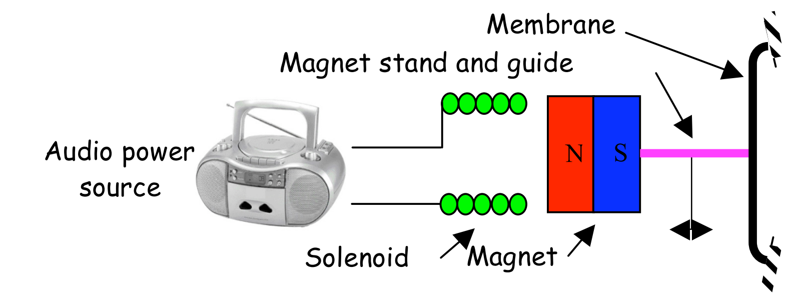
The structure of our earphones is different from those usually found in the literature. Normally, the solenoid is mobile and the permanent magnet is fixed. The light weight of the solenoid limits the inertia of the system allowing it to vibrate more freely and quickly.

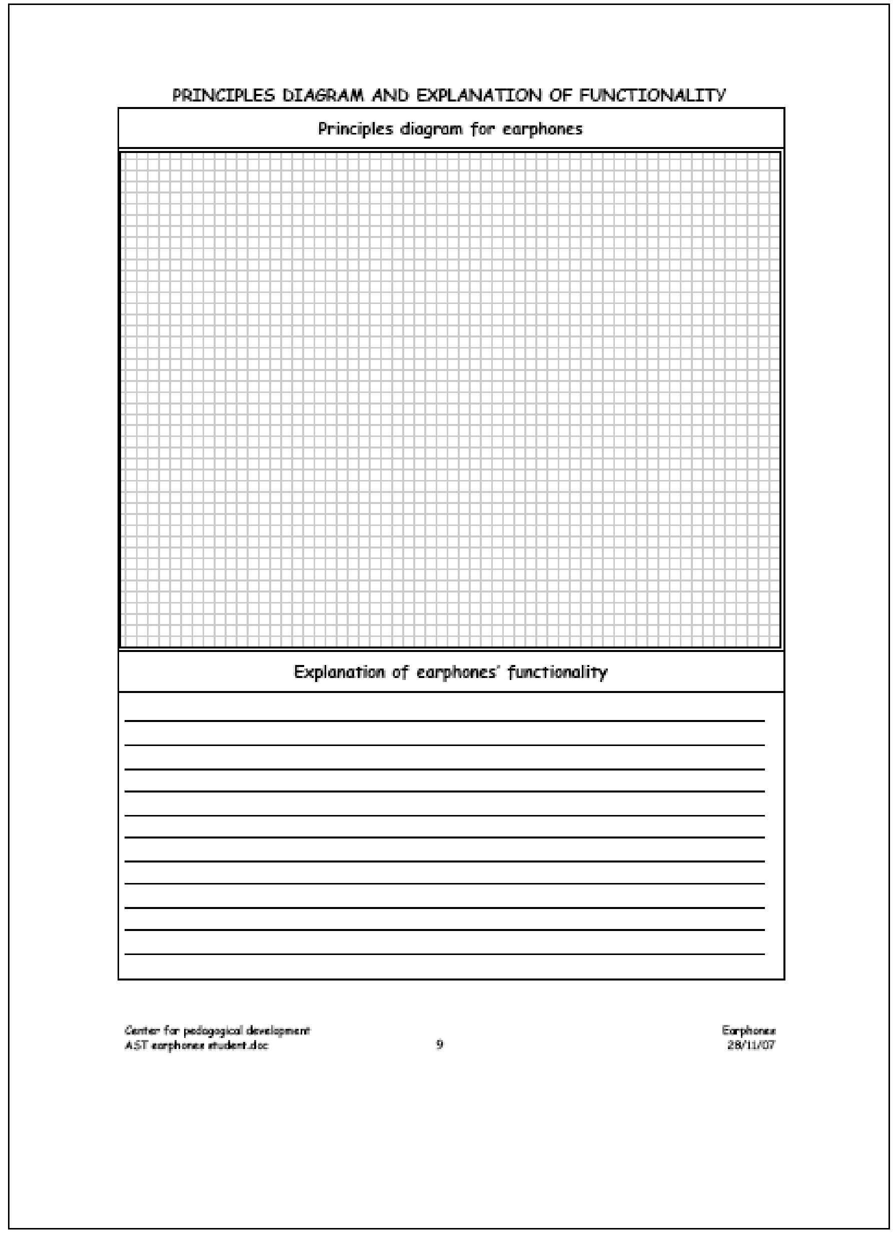
In our earphones, the permanent magnet is mobile and affixed to the membrane, and the solenoid is fixed. This choice was not made lightly. Indeed, we wanted earphones we could take apart and that are impervious to students who are less than respectful for the materials. In class, the wires of a solenoid do not withstand being taken apart. In addition, since the weight of our solenoid is comparable to the small permanent magnet, there was no advantage to retaining a mobile solenoid.

Example of a principles diagram



Examples of explanations of the above diagram

- When the current circulates in one direction in the solenoid, it generates a north pole facing the north pole of the magnet. A force of repulsion appears and the membrane is propelled towards the right. The membrane pushes the air, thus creating a compression zone.
- When the current circulates in the other direction in the solenoid, it generates a south pole facing the south pole of the magnet. A force of attraction appears and the membrane is propelled to the left. The membrane then pulls the air in front of it, creating a depression zone.
- It is these compression and depression zones that generate the sound waves.



PRINCIPLES DIAGRAM AND EXPLANATION OF FUNCTIONALITY

Principles diagram for earphones
Explanation of earphones' functionality

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N.B. Each team should have an ohmmeter (multi-meter) at its disposal. The notion of resistance however, should be introduced.

#	Anomalies and resistances	R (Ω)
0	None	Between 8 and 14
1	The solenoid wire is not varnished.	Ideally 0
*2	The magnet is too far from the solenoid.	Between 8 and 14
*3	The number of whorls is insufficient.	Below 8
4	The solders are imperfect because of the varnish.	Ideally, infinity
5	There is a short circuit in the connector.	Ideally 0
*6	The cover has no holes.	Between 8 and 14
*7	The movement of the membrane (cover) is blocked (the magnet is firmly leaned on the solenoid).	Between 8 and 14
8	There are no magnets (false magnets).	Between 8 and 14

* Means these earphones work. You must find the anomaly that makes them perform poorly.
N.B. The resistances are given for ≈500 whorls of #32 wire.

#	Suggested repairs
0	None
1	Make the solenoid again using a varnished wire.
*2	Bring the magnet closer to the solenoid.
*3	Make the solenoid again using more whorls.
4	Re-solder the connections (scrape off the varnish).
5	Locate and eliminate the short circuit.
*6	Drill many holes in the cover.
*7	Shorten the pin in order to move the magnet further from the solenoid.
8	Add a functional magnet.

STUDY OF EARPHONES' ANOMALIES		
Station #	Defect	Suggested repair
1		
* 2		
* 3		
4		
5		
* 6		
* 7		
8		

*Means these earphones work. You must find the anomaly that makes them perform poorly.

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This last section has several aims:

- **Skim the general fields of training and axes of development chosen.**
- **Skim the targeted cross curricular competency.**
- **Reflect upon the cultural resources.**
- **Make a short reflective and meta-cognitive flyover of the LES.**

INDIVIDUAL AND PLENARY REFEXION

Discussion tracks

1. Through which source (internet, dictionary, manuals, etc.) did you find your information about theoretical notions (scientific and technological concepts)?
2. Through which source did you find the information regarding the functionality of earphones?
3. Which strategies or methods did you use to locate the defects in the different sets of earphones?
4. Do you think you possess the necessary qualities to work in the field of electronics repair?
5. If your earphones became defective, would you buy another pair or would you try to have them repaired? Justify your choice, keeping in mind: the environment, salaries and working conditions of foreign workers, cost and repercussions of transportation.
6. Identify the impact of the use of earphones on the lives of individuals in our society.

MY NOTES

ANNEX 1 (Evaluation Grid)

Student's name: ______________________

Learning situation: **EARPHONES**

Development of competency 2

Working document

Evaluation criteria	1-2	3	4	5
Formulation of an appropriate questioning. Pages 2, 7 and 11 of the student booklet.	The student **transcribes the mandate** without proposing any questions related to the analysis of the earphones. He **recognises the most obvious components of the earphones**.	The student proposes **questions in relation to the analysis** of the earphones. He **wonders about the function of the main components of the earphones.**	The student proposes a **complete questioning to diagnose the anomalies** in the earphones. He **wonders about all the components** and their relationship to one another.	The student proposes a **complete questioning concerning the function of the earphones and foresees a link with the anomalies.** He wonders about the **ethical and social aspects** related to the use, repair, and consumption of the technical object presented.
Pertinent use of the concepts, laws, models and theories of science and technology. Page 8 of the student booklet.	Following the experiment, the student **recognizes the components of the earphones he studied previously** without relating them.	Following the experiment, the student **identifies some components** of the earphones and **attributes functions** to them in relation to theoretical notions.	Following the experiment, the student **identifies the most pertinent components** of the earphones and **attributes functions** to them in relation to theoretical notions.	Following the experiment, the student **identifies the components** of the earphones and **systematically attributes functions** to them **based on theoretical notions**.
Production of pertinent explanations, solutions or interventions. Pages 9 - 10 of the student booklet.	The **relationships established are not pertinent** to the identified components. His diagrammed and written **explanations make it difficult to understand** how the earphones work.	The **relationships established are adequate** for the identified components. He supplies a **brief explanation** with the help of a principles diagram and theoretical notions that **allow for a partial understanding** of how the earphones work.	The **relationships established are pertinent** for all the identified components. He supplies a **complete explanation of how the earphones work** with the help of a principles diagram and theoretical notions.	The **relationships established are detailed and pertinent** for the identified components. He supplies a **detailed written and diagrammed explanation** to understand how the earphones work.
Adequate justification for explanation, solutions or interventions made. Pages 10 - 11 of the student booklet.	The student **identifies the obvious defects** in the analysed earphones and suggests adequate repairs.	The student **identifies the major defects** in the analysed earphones and suggests **adequate repairs, sometimes based on theoretical notions.**	The student **explains all the defects** in the analysed earphones and suggests **adequate repairs based on theoretical notions.**	The student **explains all the defects** in the analysed earphones and suggests **adequate repairs based on theoretical notions.** He proposes **modifications to improve** their function.

ANNEX 2 (suppliers for specialised materials).

Nickel-chromium wire, enamelled (varnished) or unvarnished copper wire
Prolabec
2213 le Chatelier Street
Laval (Quebec)   H7L 5B3
CANADA

Telephone: (450) 682-5118 or (800) 556-5226
Facsimile: (450) 682-6468 or (800) 556-8182

http://www.prolabscientific.com/Electricity-p-1-c-688.html

Strong magnets
Lee Valley Tools Ltd.
P.O. Box 6295, Station J
Ottawa, ON K2A 1T4

Telephone: (613) 596-9202
Facsimile: (613) 596-9502

http://www.leevalley.com/hardware/page.aspx?c=1&p=42348&cat=3,42363