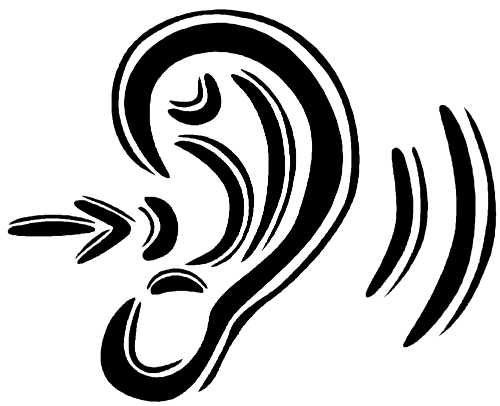
centre de développement pédagogique
pour la formation générale en science et technologie



If walls could talk…

Teacher's document

WORKING DOCUMENT

March 2009

Outline of the LES « If walls could talk »

NOTE: **This LES was designed within the framework of training sessions. It will require adaptation before being used with students.**

PREPARATION

1 Catalyst

- Put into context with background music from « Mission Impossible »

2 Activation of previous knowledge

- Analysis of a concepts exploration card with a large group
- Review of design and analysis technological processes

REALISATION AND INTEGRATION

3 Learning activities

- What is sound? (Use of the film or of demonstrations)
- Guided technological analysis process
- How is sound measured?
  (dB scale)

4 Establishing a plan

- Why analyse?
- Specifics of the challenge – specifications booklet

5 Complex task

- Elaboration of the design process for the listening device

6 Synthesis activity

- Questioning relative to the prolonged use of earphones and exposure to noise
- Auto evaluation, esteem building and transfers
  - Critical analysis of your process
  - Taking stock of your learning
  - Noise in the workplace and in daily activities
  - Anomalies and aging

OVERVIEW OF THE TASK

If walls could talk

Target audience:	2nd cycle of secondary school – 1st year of the cycle – 1st semester of the school year
Type of work:	Individual and in teams of two, depending on the activity
Class time required:	4 - 75 minute periods

Intentions

Pedagogical Aim

- Allow the student to grasp the design process.
- Allow the student to follow their first technological process analysis in context.
- Allow the student to grasp concepts from the living, material and technological worlds.

Educational Aim

- Face the student with a challenge that is accessible but fun in order to arouse his/her interest and act on his/her motivation.
- Lead the student to make informed choices as to his lifestyle habits and to the consequences that these may have on his health.

Targeted disciplinary competencies:

C-1 To propose explanations for or solutions to scientific or technological problems
C-2 Makes the most of his/her knowledge of science and technology
C-3 Communicates in the languages used in science and technology

Competencies 1, 2 and 3 are targeted. The student is placed in a design process from the very beginning. He must analyse an object and become familiar with the scientific and technological concepts in order to outline all the aspects of the problem and bring his design to term.

Targeted cross-curricular competencies:

- No cross curricular competency is targeted.

<table>
<tr><td>Broad Area of Learning</td><td>Health and well being
Axis of development:
Awareness of the consequences for health and well-being of his/her personal choices:

The purpose of the design is to allow the student to become conscious of different auditory anomalies and of the consequences of his environment on his auditory acuity.</td></tr>
<tr><td>Involved worlds and compulsory concept(s)</td><td>Living world
• Sensory receptors (ear)
• Circulatory system

Material World
• Compressible and non compressible fluids
• Pressure
• Frequency
• Decibel scale

Technological world
• Standards and representation (diagrams and symbols)
• Types of links
• Typical functions
• Materials</td></tr>
<tr><td>Community resources</td><td>• CSST
• Association for the hearing impaired
• Diabetes Québec
• History of medicine and the development of medical instruments</td></tr>
<tr><td colspan="2">Evaluation:
The evaluation of all the criteria of disciplinary competencies 1 and 3 is appropriate in this learning situation. It is also possible to collect traces for criteria 1 for competency 2.

Given the time allocated to this LES, it would be more appropriate to target one or other of the disciplinary competencies.</td></tr>
<tr><td colspan="2">Global context:
The student must design an instrument that allows him to listen to a recording that is playing on a cassette from inside a “top secret” package. To do so, he must analyse existing objects having a similar function.</td></tr>
</table>

TECHNOLOGICAL ANALYSIS OF A STETHOSCOPE

(Version 5)
February 2009

INTRODUCTION

The present document has been created in order to supply an example of what the analysis of a technical object could be in relation to the living world. This analysis will not be exhaustive, rather limiting itself only to some aspects of what an analysis can be. Thus, we will linger only on historical, scientific and technological aspects.

How do we proceed? Where do we start? In what order should we proceed? How do we organize the study? For a neophyte in the realm of technological analysis, these are inevitable questions.

Here is the list of the stages and questioning that have led us to this analysis:

1. Review of notions of acoustics: the nature of sound, how sound moves, representing sound waves. How to simply represent the scientific concepts which form the basis of the operation of a stethoscope?

2. How to represent a basic stethoscope in relation to the ear and the sound source (choice of the heart).

3. Do we have illustrations to show that? Carry out cut view diagrams (choice of cut view), simplification of the concepts, reduction of explanations to their simplest form (avoid details unnecessary to comprehension).

4. How to represent the construction of this object? Again, choose a cut view that illustrates the whole object. What dimensions do we give the diagrams? How do we not overload each page, while keeping together information that is related, at the same time allowing global comprehension of each concept? How do we identify components without getting in the way of global comprehension (space out the information on the diagrams themselves)?

5. To deal with the historical aspect, you must do some research on the Internet, sort what is really useful, choose illustrations, organise them visually, and mention the sources.

Carrying out the analysis means that you review the organisation of information several times; add diagrams; choose modes of representation; modify (colours, thickness of lines, textures, etc.); rework page layout and group information differently until you come up with an acceptable document.

There are so many facets to take into account to carry out even as simple an analysis as that of the stethoscope!

THE STETHOSCOPE

The **stethoscope** is an acoustic medical instrument, used for auscultation, which is listening to the body's internal sounds.

History

XIXth century stethoscopes

The stethoscope was invented in 1816 in France by Doctor **René Laennec.** At the time, the stethoscope was simply a bunch of papers rolled up, allowing the doctor's ear to be distanced from the patient for reasons of modesty. He thus created mediate, as opposed to immediate auscultation, where his ear was placed directly on the patient's chest. The first written description of his system dates back to the 8th of March 1817. Later, Laennec built several models out of wood.

René Laennec at a patient's side in 1816 (illustration)

This model was improved upon in 1830 by **Pierre Piorry,** who built an ivory adaptor on the auricular side. Around the same period, a flexible tube connects the pavilion to the earphone, but the rigid model persists for several decades.

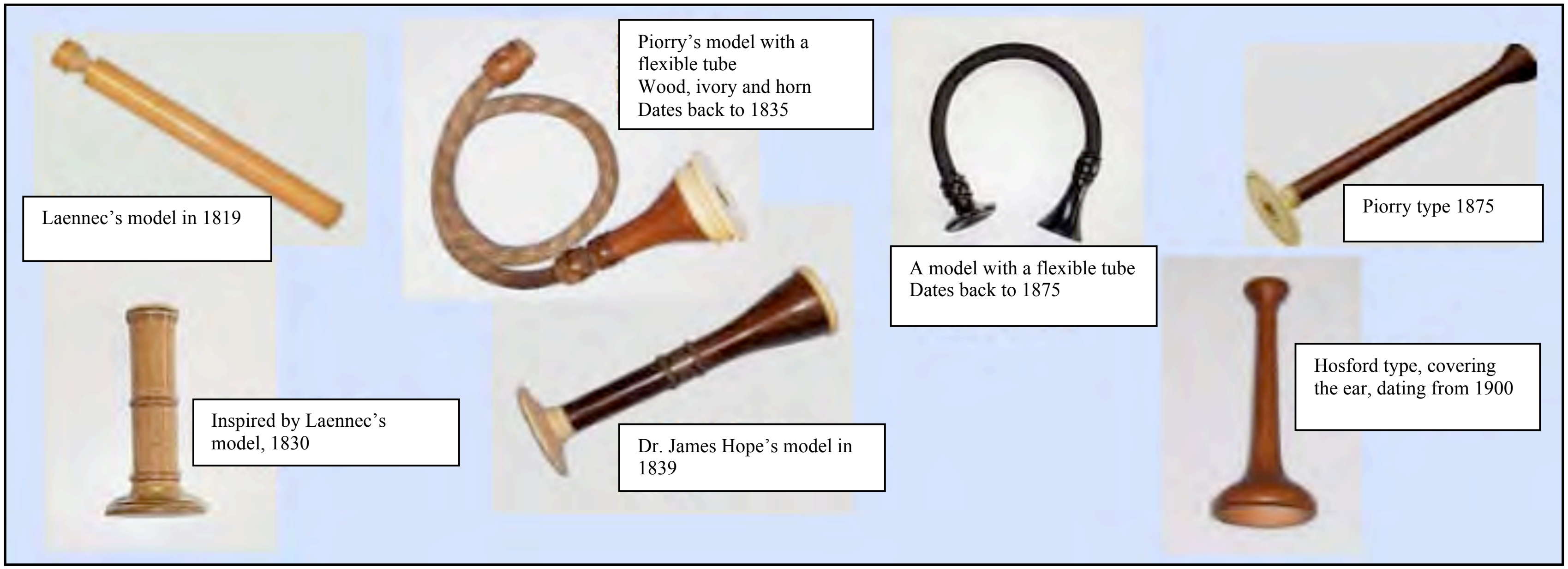
The binaural (with two earpieces) was imagined as early as 1829, but only built in 1851. The tube was made out of rubber, but this solution was too fragile and was abandoned. A second, more rigid model using metallic tubes saw the light of day in 1852.

Around 1870, differential stethoscopes appear: two pavilions, each mounted on a tube and connected to one ear, were meant to compare auscultations from two different areas.

In 1961, **Doctor David Littmann** created the contemporary stethoscope equipped with a double reversible pavilion, which is still used today.

XIXth century stethoscope

Photos and text drawn from the following sites: http://www.antiquemed.com and from the WIKIPEDIA encyclopedia: http://fr.wiwipedia.org



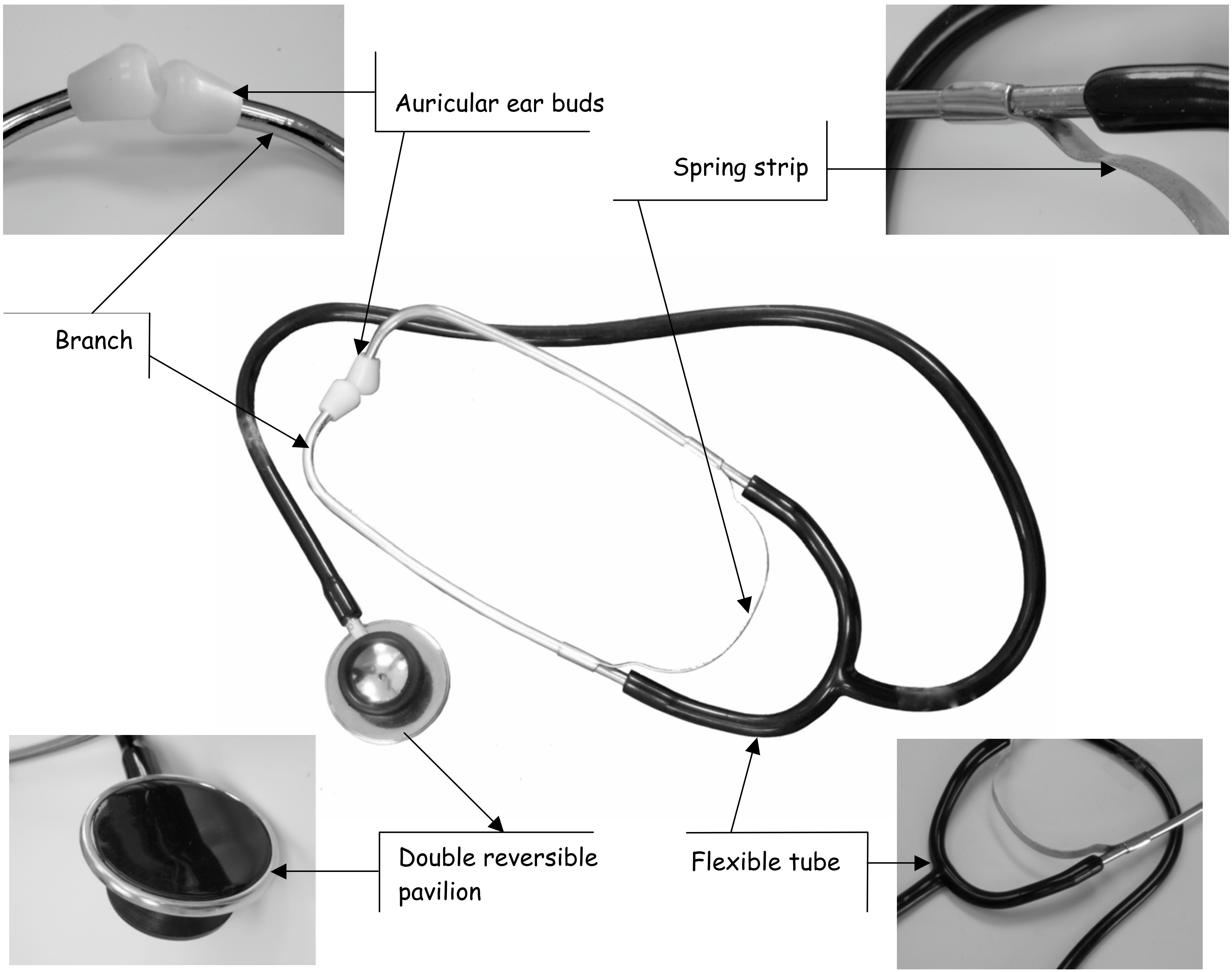
Contemporary stethoscope

Currently used stethoscopes include one or two pavilions, metallic parts equipped with a diaphragm that is placed on the patient's skin. This diaphragm, which vibrates due to body sounds, is connected by one or two flexible tubes whose ear buds the operator (mostly doctors or kinesiologists) places in his ears. The rigidity of the system at the auricular level is ensured by a metallic frame: the lyre. By its construction, the stethoscope includes an acoustical amplifier (large pavilion, small earphones). Captors can filter certain frequencies, to collect sounds that are more specifically high or low, depending on the diagnosis to be made. Electronically amplified models have also been made, without real commercial success.

The stethoscope is mostly used to listen to heartbeats or respiration, but may also be used to listen to the intestine and blood circulation (essentially arterial) as well as to foetal sounds.

Photos and text drawn from the following sites: http://www.antiquemed.com and from the WIKIPEDIA encyclopedia: http://fr.wiwipedia.org

NOMENCLATURE



SOUND AND THE EAR
Our heart beats...How can we hear it?

About sounds

The idea that sound is a vibratory phenomenon is very ancient. A Roman architect suggested it 2000 years ago.
Sound can be propagated in an environment that can react elastically and that can by this very fact, transmit vibratory energy. We need only shake the matter in this environment near the source to transmit this movement to an intermediate environment then to the receptor a little farther along.

In 1692 an experiment by Von Giesecke proved that sound could not be transmitted in a vacuum. The human auditory system can detect sounds of very different heights, intensities and timbers.

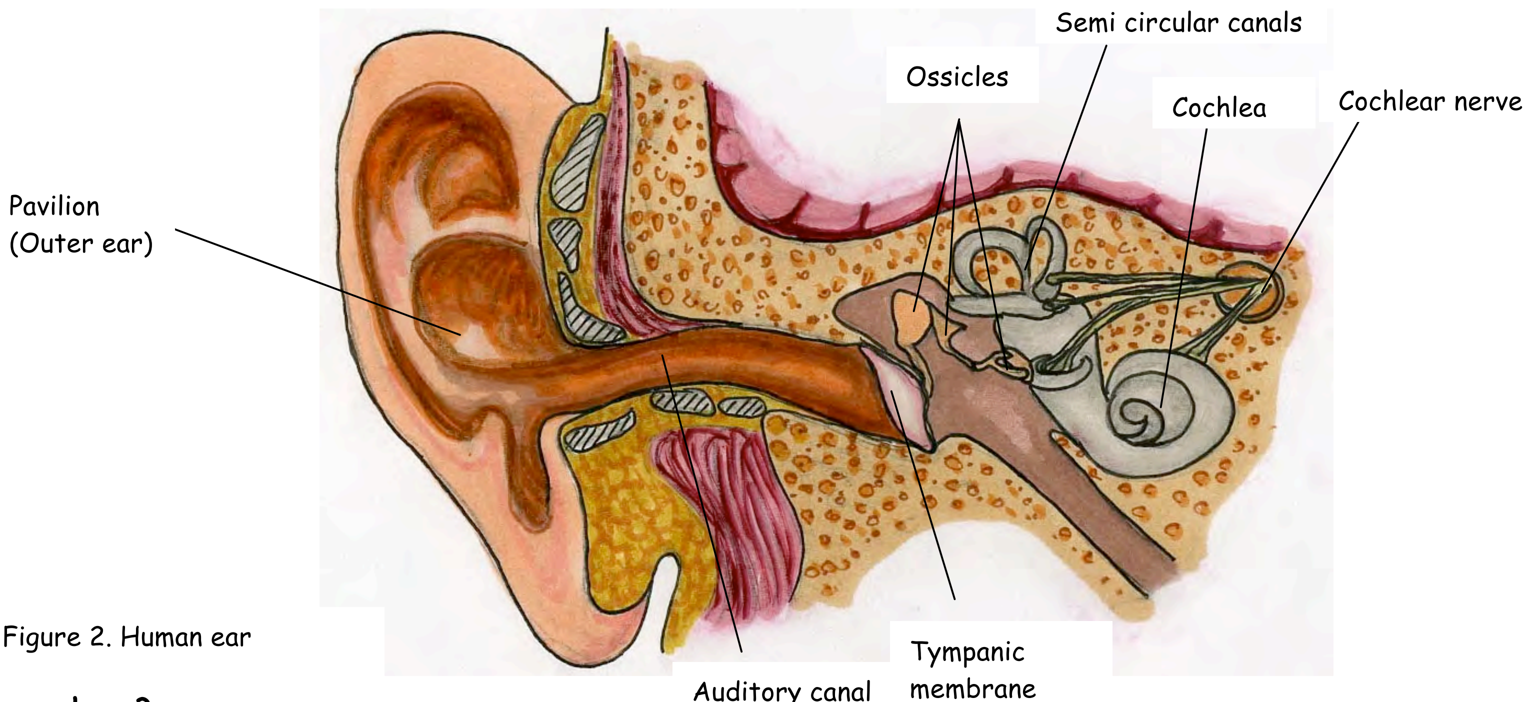
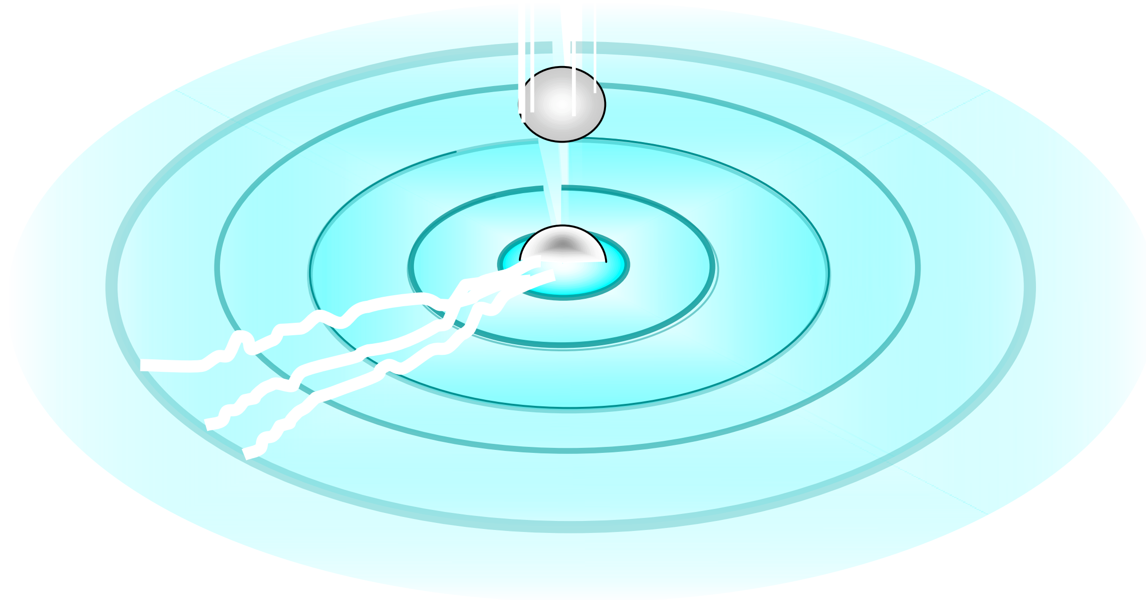


Figure 2. Human ear

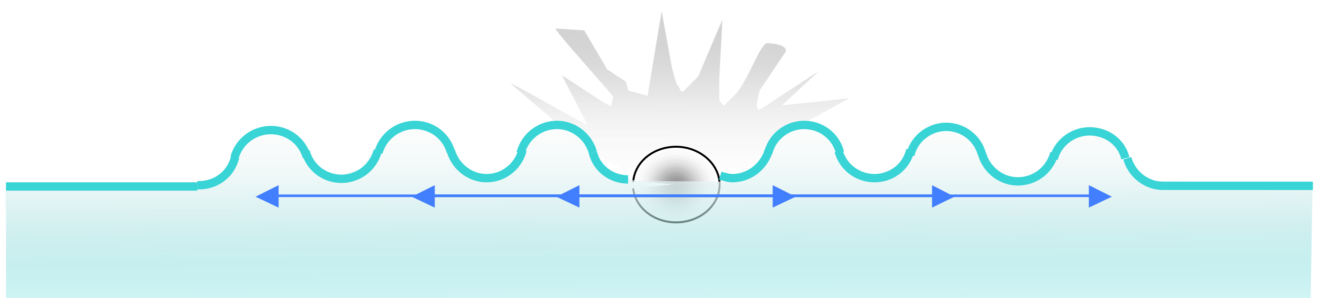
How do we hear?

Let's just say, briefly, that the ear transmits sound to us thanks to vibrations coming from the ambient air, captured by the pavilion of the outer ear.
These vibrations are then transmitted to the brain, thanks to oscillating bones that act upon a liquid situated in a cavity (cochlea).
This fluid transmits hydraulic waves to capillary cells that transmit in turn by vibrating electrical impulses to the nerves.

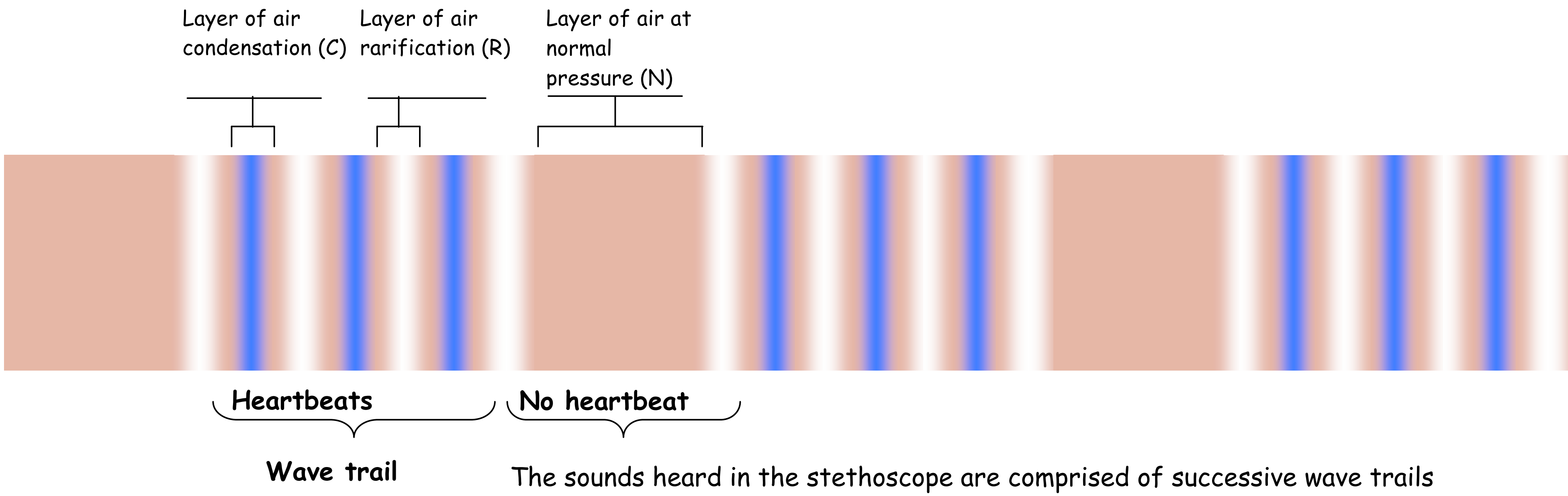
THE UNDULATORY PHENOMENON



If we were to drop pebbles into a puddle of water at intervals of a few seconds, we would see a series of wavelets forming every time. This is an undulatory phenomenon. Since the surface of the water is flat, in a cut view we would see the phenomenon as it is represented below.

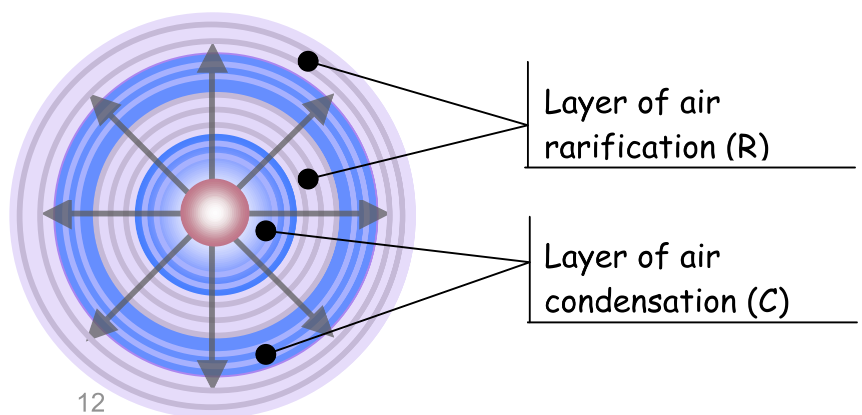


Imagine now that the pebble is replaced by a beating heart. For each heartbeat, a trail of waves is transmitted from the chest outward to the skin. Once at the receptor of the stethoscope, these beats are transmitted to the diaphragm which beats in its turn. Then the vibrations are transmitted to the air inside the receptor. Obviously the illustration below does not accurately reflect heartbeats but rather illustrates the presence of waves. In the air, waves move in all directions starting from the source until they meet obstacles from which they are reflected and go in another direction. That is what happens inside the stethoscope tube.

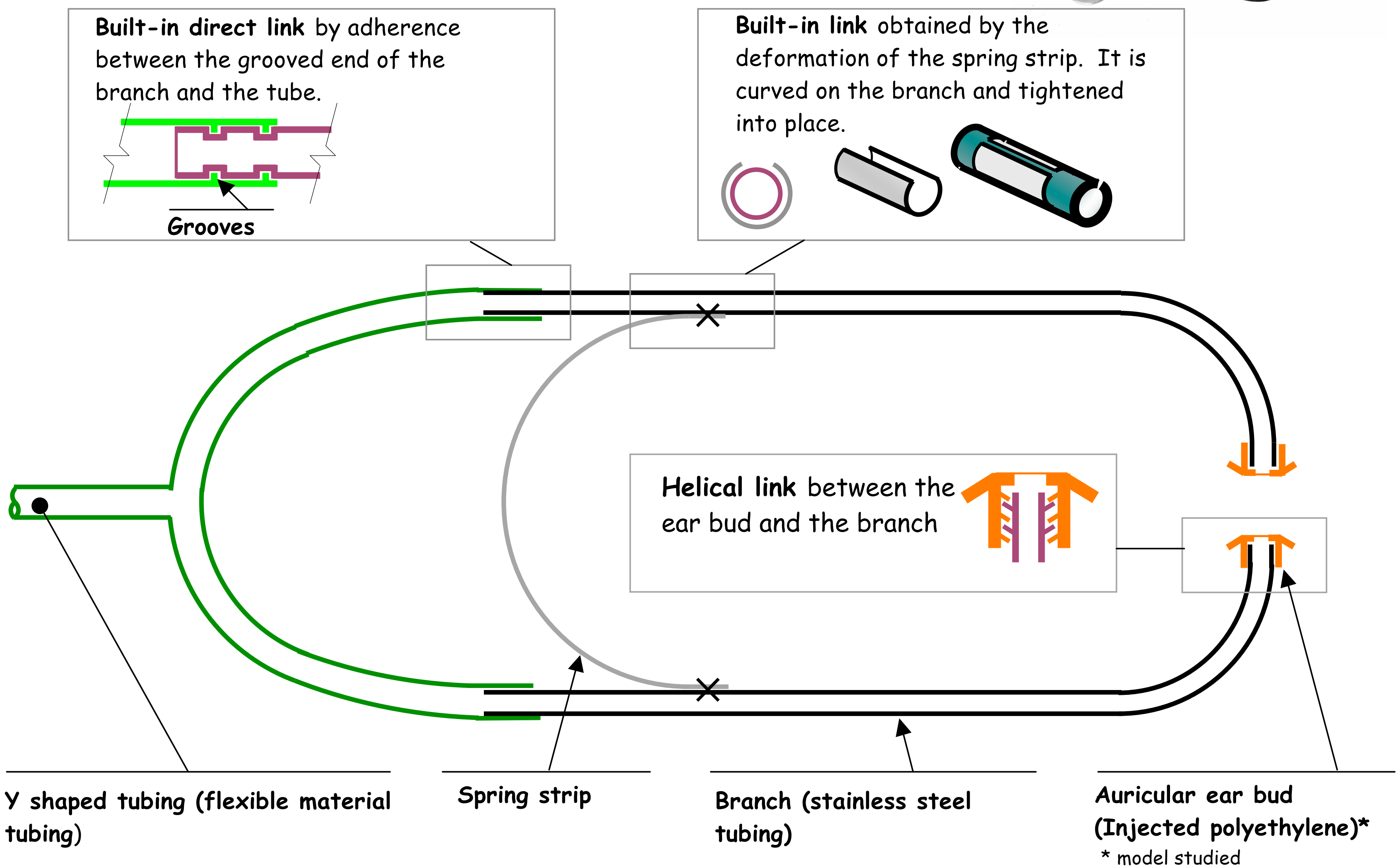


The sounds heard in the stethoscope are comprised of successive wave trails (heartbeats)

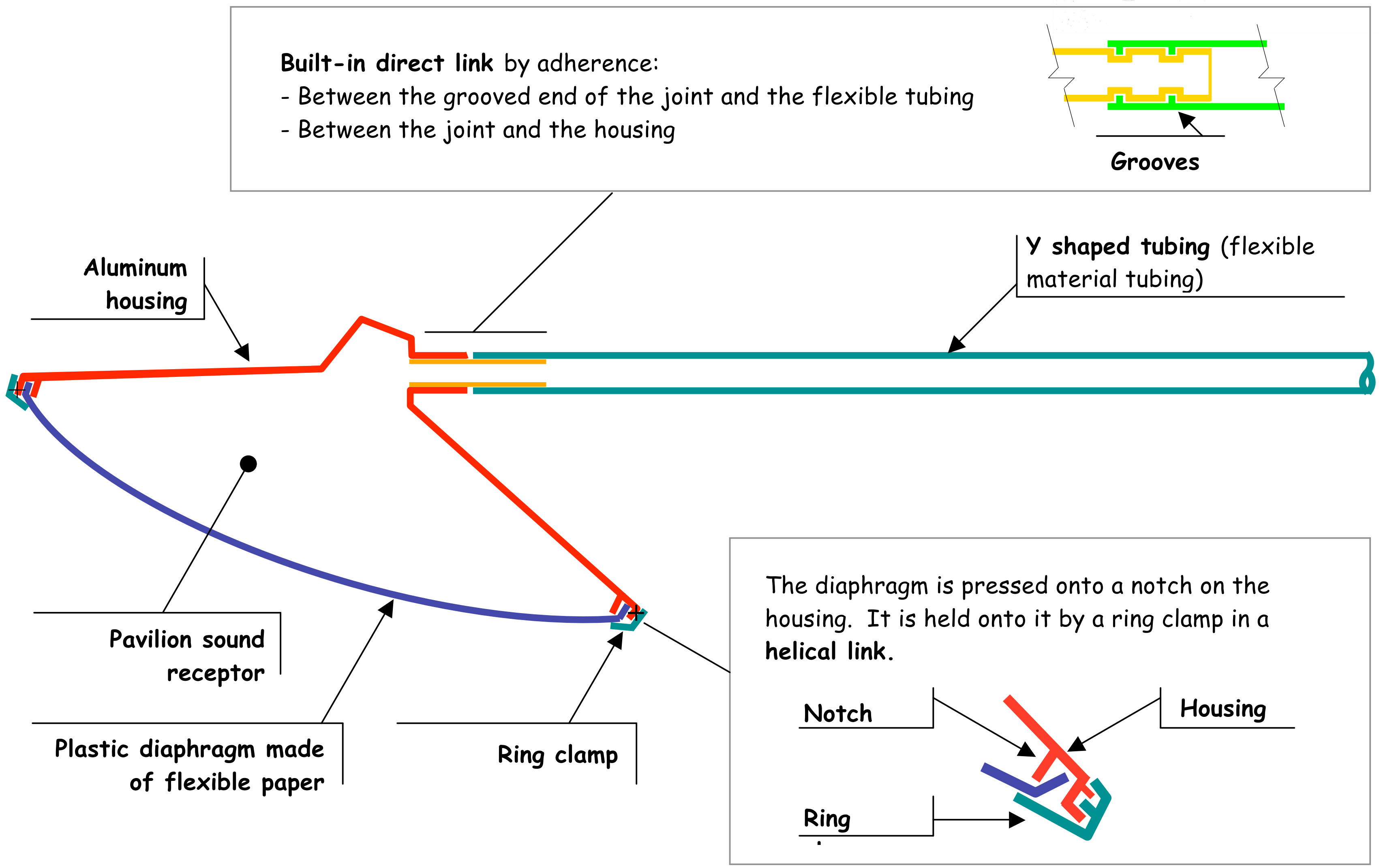
In an elastic environment, sound is displaced all around the sound source (S) as if it were a sphere



CONSTRUCTION DIAGRAMS (« user » side)



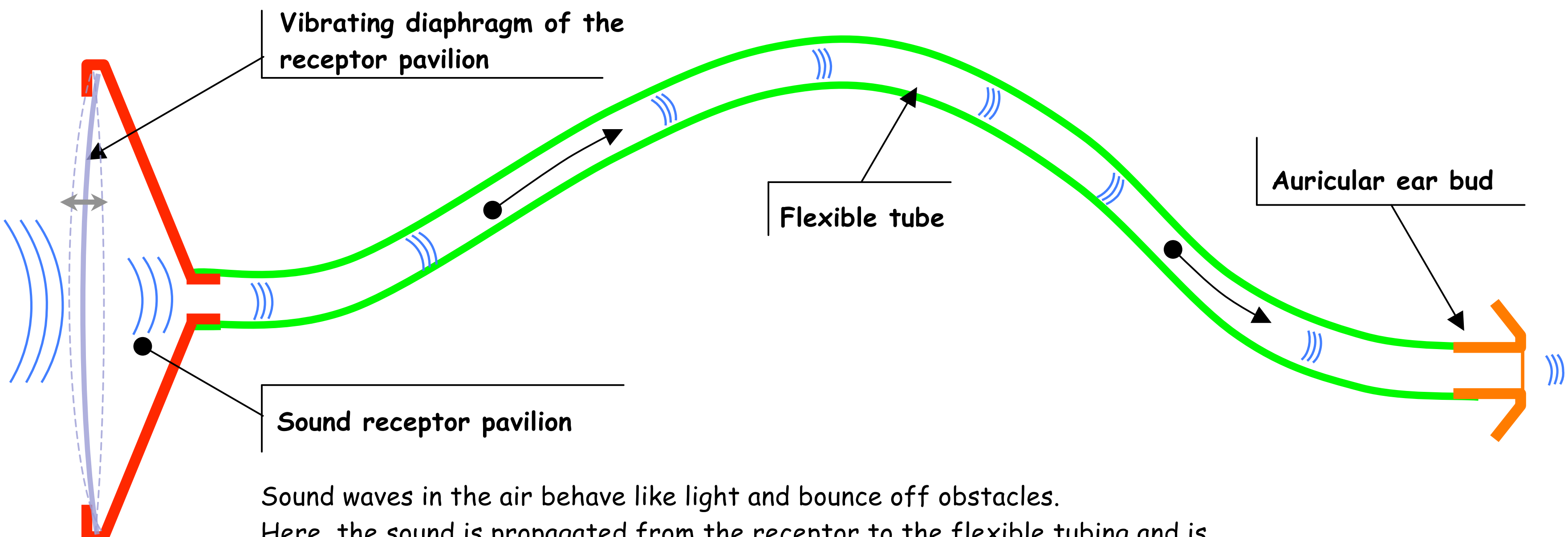
CONSTRUCTION DIAGRAMS (« patient » side)



FUNCTION ET PRINCIPLES OF OPERATION OF A STETHOSCOPE

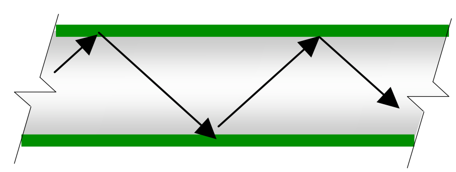
FUNCTION OF THE STETHOSCOPE

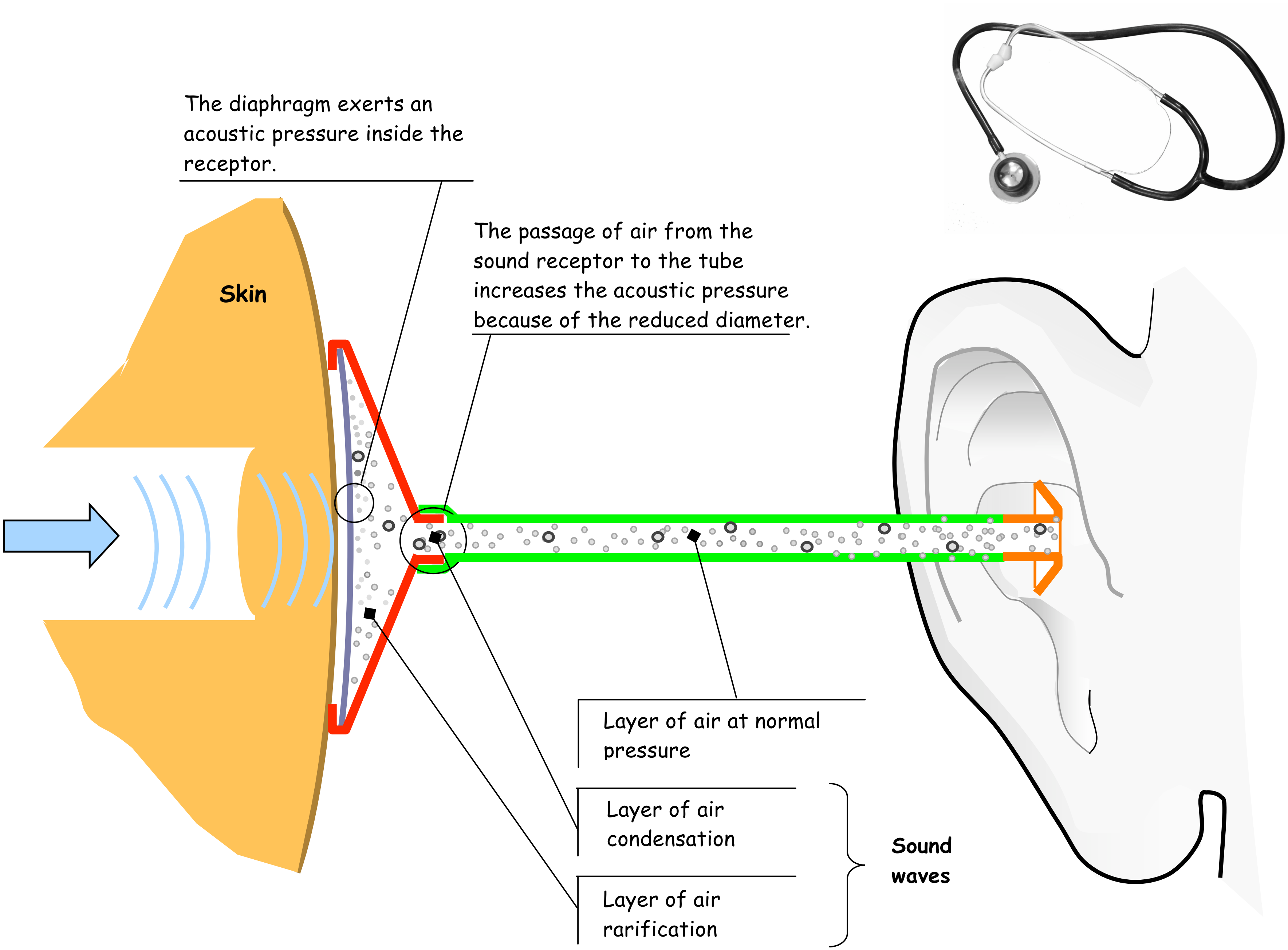
The **stethoscope** is an acoustic medical instrument, used for auscultation, which is listening to the body's internal sounds



Sound waves in the air behave like light and bounce off obstacles.
Here, the sound is propagated from the receptor to the flexible tubing and is amplified towards the auricular ear buds.
In addition, the stethoscope creates an enclosure into which external sounds do not create interference with internal sounds.

The waves bounce off any obstacles they meet.




The diaphragm exerts an acoustic pressure inside the receptor.
The passage of air from the sound receptor to the tube increases the acoustic pressure because of the reduced diameter.
Skin
Layer of air at normal pressure
Layer of air condensation
Layer of air rarification
Sound waves

Demonstrations about sound

Video available on the CDP web site (french only): http://www2.cslaval.qc.ca/star/-CDP-o-Science-et-technologie-

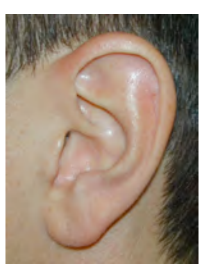
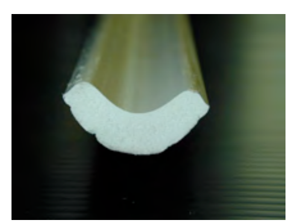
The analogy with the marbles will serve as a base for the following five demonstrations. They will allow better understanding of the phenomenon of sound waves in the air. The five demonstrations deal with the following themes:

1- The propagation of sound between two points;
2- The absorption of a sound wave;
3- Energy transported by a sound wave;
4- The reflection of a sound wave (the formation of an echo);
5- The speed of a sound wave.

Concretely, the demonstrations simply consist of aligning several glass marbles on a quarter-round that serves as a ramp. This assembly allows you to simulate a sound wave front in the air in a single direction. The simplicity of the demonstrations makes them useable in class and should captivate the students – and perhaps you as well, who knows!

•Necessary material

• 1 package of adhesive gum (blue sticky tack used to stick drawings on the wall);
• 24 glass marbles (about 1.5 cm. in diameter);
• 3 photos: a mouth, an ear, a mountain (see photos 1, 2 and 3 attached);
• 2 meters (8 feet) of concave quarter-round (see photo 4 attached);
• 1 piece of duct tape;
• 1 large heavy filing cabinet (as a support for the system);
• 1 piece of solid metal (a mass of 500 grams used for a scale).

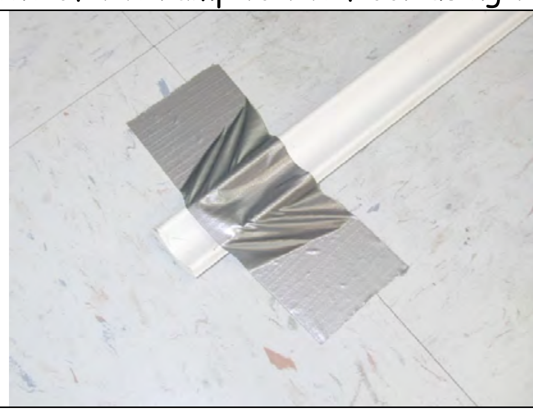
Photo 1	Photo 2	Photo 3	Photo 4
			

Assembly of the ramp

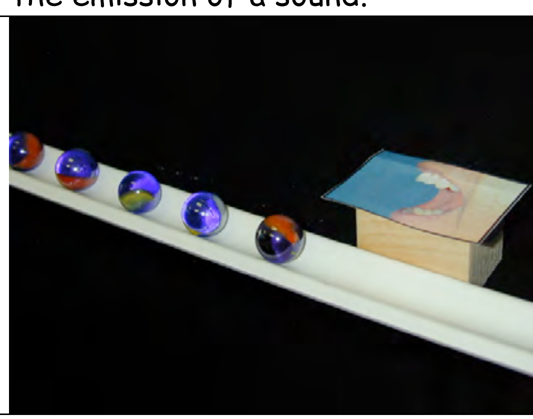
1. Jam one extremity of the quarter-round in to the upper handle of the filing cabinet. The concave part of the quarter-round should point upwards in such a way that it forms a ramp where the marbles will roll.



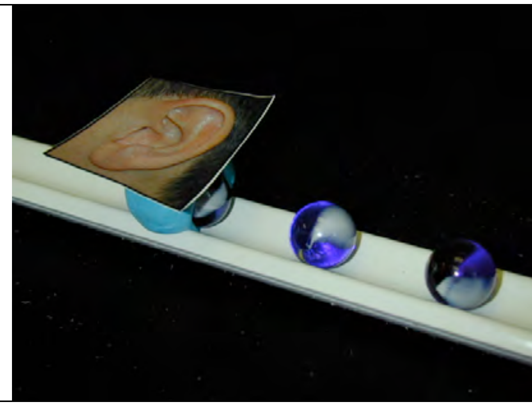
2. Affix the other end of the ramp to the floor using the duct tape.



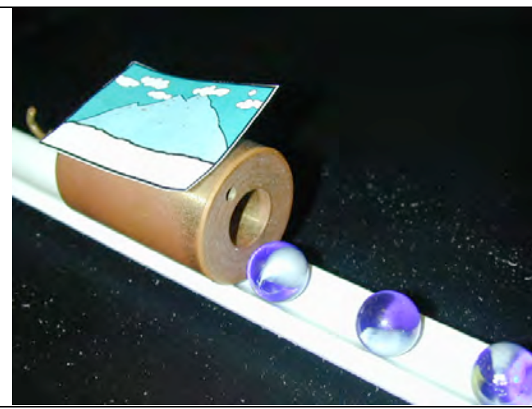
3. Install the mouth at the base of the slope, where the ramp first touches the floor. The opening of the mouth must face the bottom of the slope so that a marble rolling down the slope seems to come out of the mouth. This is our way of simulating the emission of a sound.



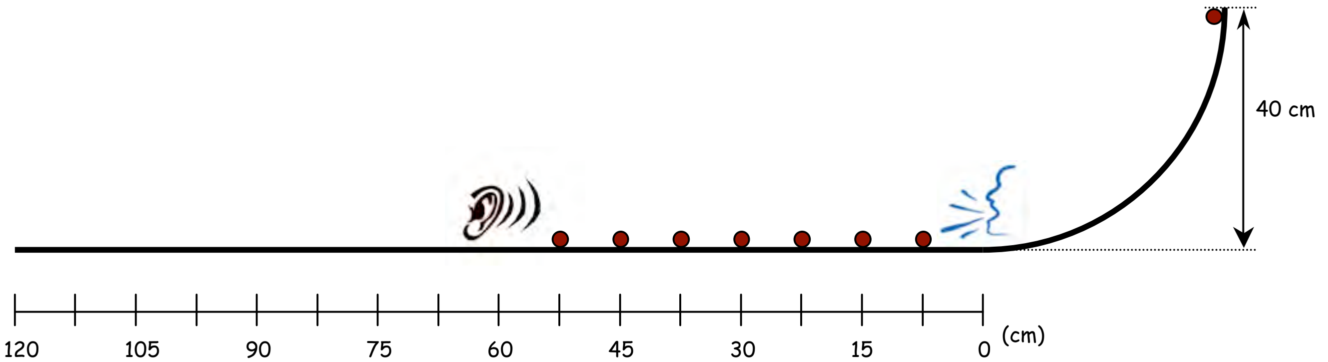
4. Install the ear, further along, on the ramp. Its position will vary depending on the demonstration. The sticky tack should be shaped so as to retain a marble that collides with it. This is our way of simulating the reception of a sound. .



5. Finally, for the fourth demonstration, you will simply need to replace the ear with a metal mass acting as a mountain.



First demonstration: propagation of a sound wave between two points



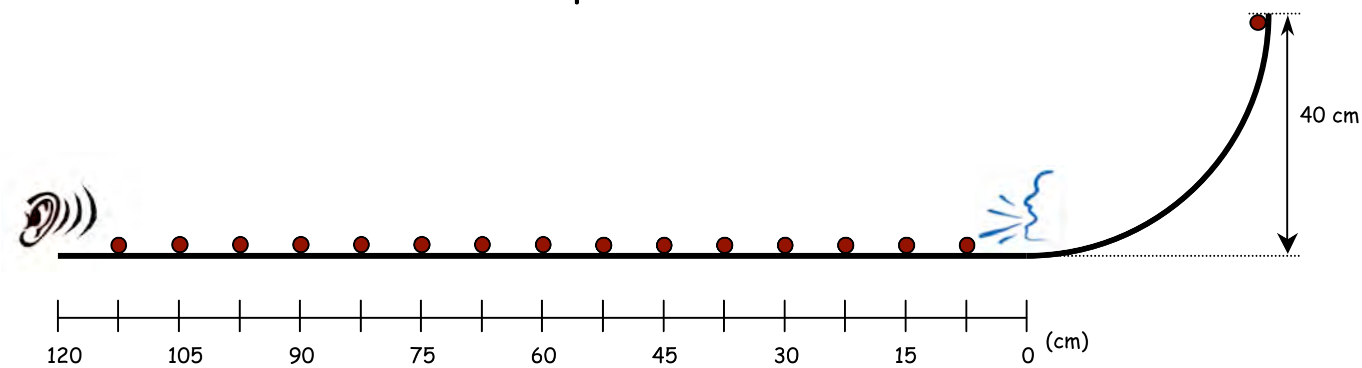
Description

The marble placed at the top of the ramp, 40cm. above the ground, has potential gravitational energy. This energy will gradually be transformed into kinetic energy (energy of movement) while rushing down the slope. When the marble passes the level of the mouth, this energy of movement will simulate the sound energy emitted by a yell. The marbles will collide like air particles upon passage of a compression sound wave. The last marble, which is the furthest to the left, will be projected onto the sticky tack and will stay there. This adhesive gum simulates the absorption of the sound energy by the ear.

Manipulations

1. Install the photo of the mouth at the base of the ramp.
2. Install the photo of the ear 60 cm. from the mouth.
3. Place 7 marbles at the positions indicated on the diagram above.
4. Hold the 8th marble at the top of the ramp at a height of 40 cm. from the floor.
5. Release the 8th marble: it rushes down the ramp and picks up speed.
6. Observe the collisions.

Second demonstration: the absorption of a sound wave



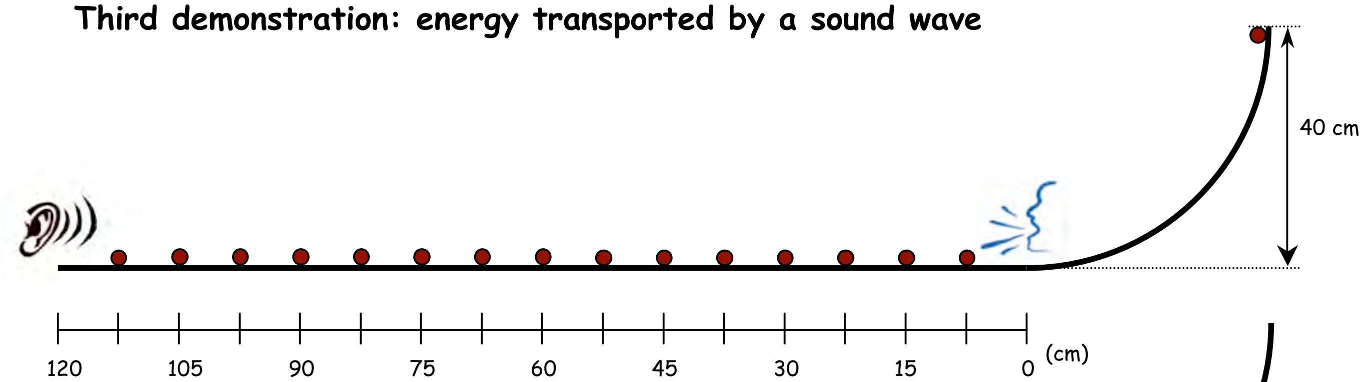
Description

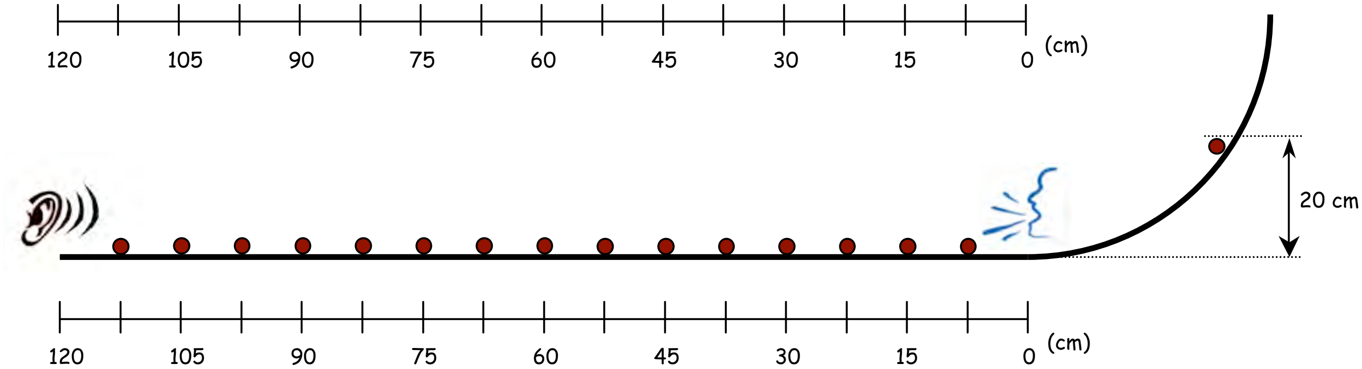
As in the previous demonstration, the marbles will also collide. Each collision entails a loss of energy. The wave will therefore not travel to the ear. A person's yell into the air has a limited range as well. The sound energy is also dissipated because of the distance.

Manipulations

1. Install the photo of the mouth at the base of the ramp.
2. Install the photo of the ear 120 cm. from the mouth.
3. Place 15 marbles at the positions indicated on the diagram above.
4. Hold the 16th marble at the top of the ramp at a height of 40 cm. from the floor.
5. Release the 16th marble: it rushes down the ramp and picks up speed.
6. Observe the collisions.

Third demonstration: energy transported by a sound wave





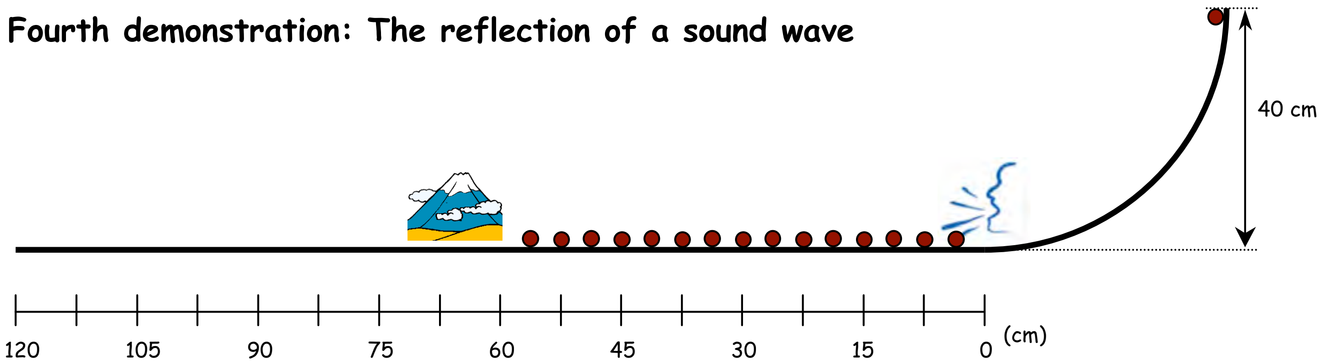
<u>Description</u>

The preceding demonstration is started over here, while varying the height at which the marble is released. This height corresponds to the energy transported by the sound wave. The higher the marble is released, the louder the simulated sound will be. The propagation of collisions should stop sooner in the case of a release from a height of 20 cm.

<u>Manipulations</u>

1. Install the photo of the mouth at the base of the ramp.
2. Install the photo of the ear 120 cm. from the mouth.
3. Place 15 marbles at the positions indicated on the diagram above.
4. Hold the 16^{th} marble at the top of the ramp at a height of 40 cm. from the floor.
5. Release the 16^{th} marble: it rushes down the ramp and picks up speed.
6. Observe the collisions.
7. Begin these manipulations again, placing the 16^{th} marble at a height of 20cm.

Fourth demonstration: The reflection of a sound wave



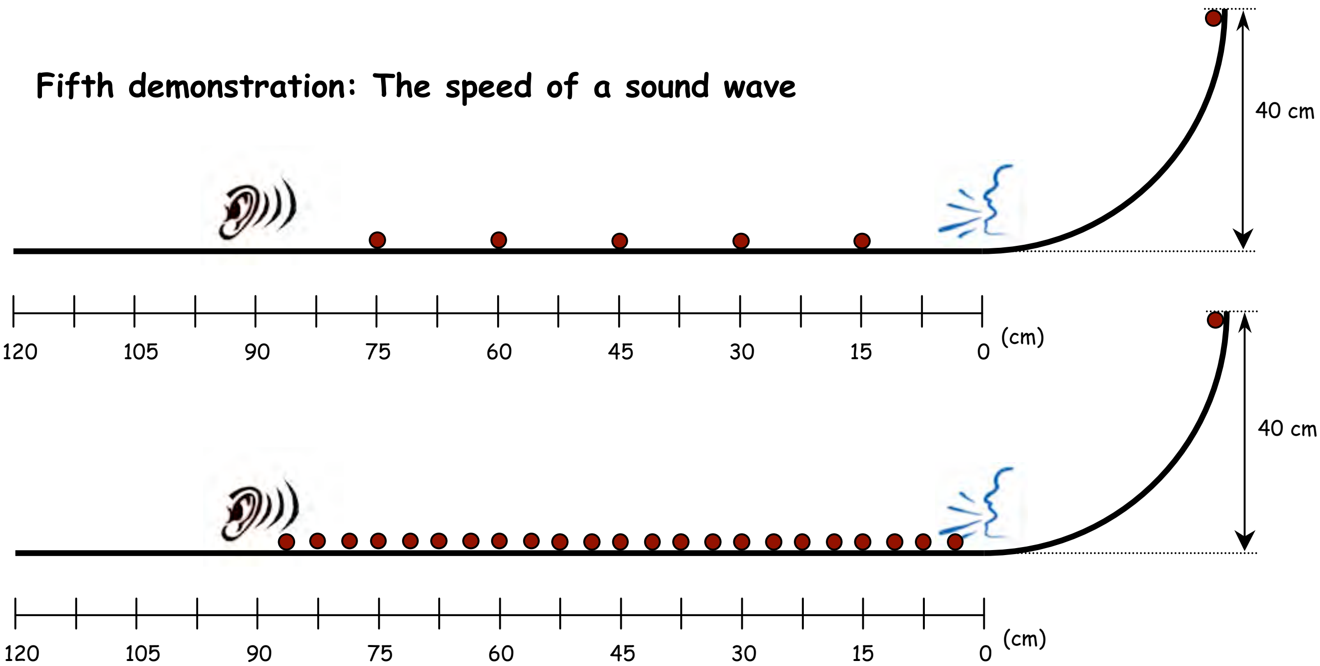
Description

Here, the collisions will spread from the mouth to the mountain. Then, like the formation of an echo, the marbles will come back in the opposite direction. The absorption effect will certainly also make itself felt. In fact, the echo will probably not come back to its emitter.

Manipulations

1. Install the photo of the mouth at the base of the ramp.
2. Install the piece of solid metal with the photo of the mountain 60 cm. from the mouth.
3. Place 15 marbles at the positions indicated on the diagram above.
4. Hold the 16th marble at the top of the ramp at a height of 40 cm. from the floor.
5. Release the 16th marble: it rushes down the ramp and picks up speed.
6. Observe the collisions.

Fifth demonstration: The speed of a sound wave



Description

Sound waves can spread in locations containing more or less particles. In solids, for instance, the density of particles is greater. Under certain conditions, the density of the air may also be greater:

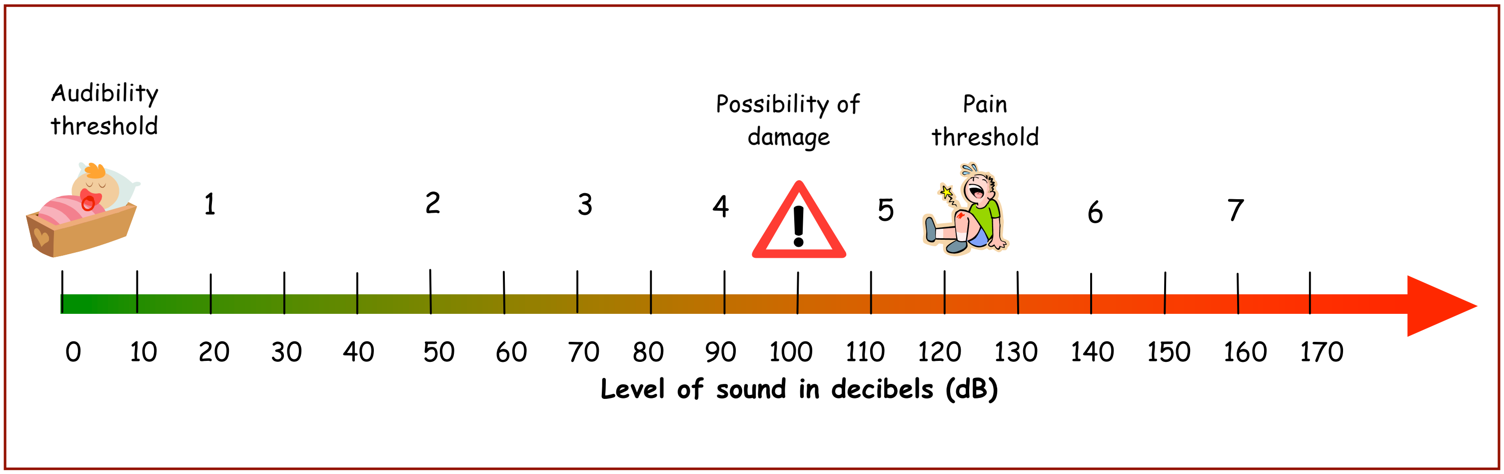
- High humidity (presence of water molecules in the air);
- Low temperature (air molecules get closer together);
- High atmospheric pressure (air molecules get closer together).

The speed of the compression wave is greater if there are more molecules. That is why cowboys heard the train coming when they pressed their ear to the iron track. The sound came to them more quickly and gave them time to prepare themselves. Sound therefore travels more quickly at sea level, in the damp cool air.

Manipulations

1. Install the photo of the mouth at the base of the ramp.
2. Install the photo of the ear 90 cm. from the mouth.
3. Place 5 marbles at the positions indicated on the diagram above.
4. Hold the 6th marble at the top of the ramp at a height of 40 cm. from the floor.
5. Release the 6th marble: it rushes down the ramp and picks up speed.
6. Observe the collisions.
7. Begin these manipulations again, using 23 marbles.

The decibel scale



Associate the following sounds with the numbers 1 through 7 on the decibel scale.

A. Rock concert - **5**
B. Lawn mower - **4**
C. Gun fire - **6**
D. Normal conversation – **2**
E. Wind in branches - **1**
F. Permanent damage - **7**
G. Vacuum cleaner - **3**

Interesting websites dealing with sound and the decibel scale.

Agi-son.org
http://www.agi-son.org/spip.php?article45

Center for information and documentation about noise
http://www.bruit.fr/FR/info/00

Noise – Measuring the sound level – Decibel scale
http://www.linternaute.com/savoir/document/bruit

Quebecers against noise
http://www.rqcb.ca/fr/donnees_de_base.php

NOTE: Other web sites appear in the webography at the end of this document.

Suggested materials for the design of the listening device

Various membranes:

- Balloons
- Acetates
- Document holders
- Plastic bags

Various tubing

- 10mm diameter latex tubing, 1 cm long
- 7mm diameter latex tubing, 1 cm long
- 7mm diameter vinyl tubing (transparent)
- 5mm diameter vinyl tubing (transparent)
- Skipping rope
- 7mm diameter acrylic or glass tube (rigid tubing) cut in 10 cm sections

Various containers and covers

- Small stainless steel bowls
- Small plastic containers (for storage or baby food jars)
- Metal and plastic covers
- Plant pot plates
- Empty tin cans

Various materials

- Hot glue
- Masking tape
- Construction foam
- Adhesive tape

Tools

- Hot glue gun
- Drill
- Set of punches

Statements for the audio file for testing the prototype

1. Keep an ear out for what I say.
2. Is there anything between your two ears?
3. This has not fallen on deaf ears.
4. Are your ears burning?
5. Let's play it by ear.
6. You can't make a silk purse out of a pig's ear.
7. Can I drop a word in your ear?
8. Are you only listening with half an ear?
9. You won't believe your ears!
10. It goes in one ear and out the other.

Webography

Web site about the history of medecine
http://www.antiquemed.com

École supérieure d'art D'Aix-en-provence
http://www.ecole-art-aix.fr/article1861.html

WIKIPEDIA encyclopedia
http://en.wikipedia.org/wiki/Main_Page

Video bell in a vacuum
http://www.youtube.com/watch?v=b8VNs5vIbPA

Mosquito ring tone: www.freemosquitoringtones#4E70B

How the ear works: www.youtube.com/ 1.webloc

Journey into the ear: www.youtube.com/.webloc

Sound waves and music: www.youtube.com/watch?v=A#4F5EE

Ear infections: www.youtube.com/watch?v=T#4EDF3

3D sound waves: www.youtube.com/watch?v=u#4F5F5

Mosquito Report: http://www.nouvo.ch/102-2

Hearing damage and loud music - abelard:
http://www.abelard.org/hear/hear.php

Centre d'information et de documentation sur le bruit : http://www.bruit.fr/FR/info/00

Witness /concerts…:
http://www.audition-prevention.org/site/actualites.php

Household devices and the decibel scale:
http://www.moinsdebruit.com/le-bruit/lechelle-du-bruit.html