# Lower Secondary Scenario 1.1: Sources of Sound

<table>
<thead>
<tr>
<th>Title:</th>
<th>Lower Secondary Scenario 1.1: The sources of Sound</th>
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<tbody>
<tr>
<td>Keywords:</td>
<td>periodic, frequency, wavelength, pitch, sound, tone</td>
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<tr>
<td>Short Description:</td>
<td>iMuSciCA Scenario around basics of sound and tone, aimed at lower secondary</td>
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<tr>
<td>Lesson Plans included:</td>
<td>Lesson Plan 1.1: The sources of Sound</td>
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<tr>
<td>Date:</td>
<td>28/03/2018</td>
</tr>
<tr>
<td>Estimated Duration:</td>
<td>2h</td>
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<tr>
<td>Educational Objectives:</td>
<td>The following scenario let students inquire: Lesson 1.1: The sources of Sound  i) how sound and music originate as vibrations (in an elastic medium)  ii) how a wave with a fixed frequency is formed on an instrument (that produces a tone of a certain pitch).</td>
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<tr>
<td>Author(s):</td>
<td>Renaat Frans, Erica Andreotti, Mieke Schuermans, Jeroen Vanesser, Jeroen Op den Kelder</td>
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<tr>
<td>Age Group:</td>
<td>Lower Secondary (approx. 12-15)</td>
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<tr>
<td>Contributor(s):</td>
<td>P. Stergiopoulos, E.Chaniotakis</td>
</tr>
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<td>Language:</td>
<td>English</td>
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</table>
Lesson Plan 1.1: **The sources of Sound - Overview**

<table>
<thead>
<tr>
<th>Time</th>
<th>Phases</th>
<th>Field</th>
<th>Description</th>
<th>Activity</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Engage/Imagine</td>
<td>A</td>
<td>Sounds of different instruments are played.</td>
<td>What could be the source of vibration in these instruments? According to ‘what is vibrating’, one can distinguish at least 4 families of musical instruments.</td>
<td>We start in the musical world.</td>
</tr>
<tr>
<td></td>
<td>Investigate/Analyse</td>
<td>S</td>
<td>By means of simple experiments: can we observe what is vibrating?</td>
<td>Observe a vibration more carefully: why does the elongation come back every time? Can a sound propagate without making contact? Sound propagates as waves through the air: what does move in a wave?</td>
<td>Our investigation of the sources of sound continues now in the scientific world.</td>
</tr>
<tr>
<td></td>
<td>Analyse/Communicate/Reflect</td>
<td>S</td>
<td>What did you discover? Discuss and come to conclusions.</td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td>Create/Design</td>
<td>E/A</td>
<td>We built simple musical instruments: an aerophone (bottle organ) and an idiophone (bottle bell)</td>
<td>Try to tune the bottle organ and the bottle chimes to notes, so you can play a simple melody on it. With some idiophones, make a rhythm.</td>
<td>Students experience what they have learned about the sources of sound in a real musical-praxis environment.</td>
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</table>
Lesson Plan 1.1: **The sources of Sound - Detail**

No specific pre-knowledge is required. Typically pupils work in groups of maximum 3 with a computer and a box with the needed material. After a short introduction, the teacher goes around, observes and guides the pupils whenever needed. Concerning the evaluation, it is important to make time for ‘contact moments’: this way the teacher can observe what the pupils really understood and can repeat the basic concepts of this lesson. It is possible for example to organise a sort of game with ‘thesis’, in which pupils have to say whether these are correct or not and in case of wrong thesis they have to correct them.

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</table>
| 1 hour | Engage | A | Sounds of different instruments are played. The pupils have to recognize to which category they belong in terms of ‘what is vibrating’. | Slide 2: | We start in the musical world. Which sound is produced by which instrument? **Solution:**
Guitar - 2
Violin - 1
Clarinet - 4
Drum - 3 |
Imagine/Investigate

Various instruments are shown. What could be the source of vibration in these instruments?

Solutions:
Guitar - chord
Drum - membrane
Violin - chord
Xylophone - massive body
Clarinet - air

It is important that the pupils read the comments in Cabri.
The sources of sound and music

Instruments with a vibrating chord are called chordophones.

Choose the correct answer, to make the violin play.

What is the source of vibration in this instrument?
- Air
- Membrane
- Chord
- Massive body

The sources of sound and music

Instruments in which the entire body vibrates are called idiophones.

Choose the correct answer, to make the xylophone play.

What is the source of vibration in this instrument?
- Air
- Membrane
- Chord
- Massive body
According to ‘what is vibrating’, one can distinguish at least 4 types of tone generators.

<table>
<thead>
<tr>
<th>Analyze</th>
<th>A</th>
<th>Slide 8:</th>
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</table>

These are our first conclusions in the musical world.

**Solutions**
- Flute - Aerophone
- Drum - membranophone
- Piano - chordophone
- Claves - idiophone
<table>
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<tr>
<th>Investigate</th>
<th>S</th>
<th>By means of simple experiments: can we observe what is vibrating?</th>
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</thead>
<tbody>
<tr>
<td><strong>Observation</strong></td>
<td></td>
<td>The ball vibrates back and forth.</td>
</tr>
<tr>
<td><strong>Conclusion:</strong></td>
<td></td>
<td>Sound is a vibration.</td>
</tr>
</tbody>
</table>

**Slide 9:**

**Experiment 1:** What is the source of the sound?

- Take a tuning fork, hammer, and a small ball.
- Hit the tuning fork with a hammer and hold the ball gently against the tuning fork.

**Observation**

- What happens to the ball?
  - [ ] Nothing happens.
  - [x] The ball goes back and forth several times.
  - [ ] The ball goes back and forth once.

**Conclusion:**

- Sound is a vibration.

**Slide 10:**

**Experiment 2:** Why does it vibrate?

- What makes the elongation come back every time?

**Observation**

- Take a ruler and put it over the edge of a table.
- Hit the end of the ruler and watch how it vibrates.

**Conclusion:**

- A vibration is caused by a repetitive movement.

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Our investigation of the sources of sound continues now in the scientific world.

Hit the tuning fork while holding the ball against the tuning fork, but not touching it (about 0.5 cm away).

**Experiment:**

Place the ruler at the edge of a table as shown in the picture. Hit the extremity and let it vibrate.
<table>
<thead>
<tr>
<th>Investigate/ Analyse</th>
<th>Slide 11:</th>
<th>Slide 12:</th>
</tr>
</thead>
<tbody>
<tr>
<td>S Can a sound propagate without making contact?</td>
<td><strong>Observation</strong> The grains vibrate because the vibration propagates through the air. <strong>Conclusion:</strong> Sound is a vibration that propagates in a medium, such as air.</td>
<td><strong>Experiment:</strong> Place the grains on the balloon stretched over the cup. Hit the tuning fork while holding the resonance chamber close to the grains like shown in the picture below.</td>
</tr>
<tr>
<td>S Sound propagates as waves through the air: what does move in a wave?</td>
<td><strong>Observation</strong> Only the compression and rarefaction of the rings do move. The rings come back to their original position and netto they do not move. <strong>Conclusion:</strong> This movement is analog to the movement of the soundwave in the air.</td>
<td><strong>Experiment:</strong> Make a wave visible in a slinky. Do this by placing the slinky horizontally on a table, stretching it and giving a pulse at one end like shown in the picture: Suggestion: use a slinky with small spring constant in order to optimize the effect.</td>
</tr>
</tbody>
</table>
Watch the following animation of a pressure wave through air: https://giphy.com/gifs/longitudinal-wave-xTiN0JzYz3s4cBS6QM

Observe one specific air particle (red points): do the particles move from one side to the other?

Observation: The air particles do not move from one side to the other and there is no net displacement.

Conclusion: The air particles move back and forth around their initial position. Sound is a pressure wave in the air.
Can sound propagate in the vacuum?

**Observation**
You hear the sound less and less hard while pumping and creating the vacuum.

**Conclusion:**
Sound cannot propagate in the vacuum because there are no air particles. Therefore no pressure wave can originate.

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**Experiment:**
Place a speaker or an alarm in a vacuum sealed container and use a pump to create the vacuum inside the container. Let the speaker/alarm make sound.

**Alternative:**
In case you don't have the right material, you can watch this video:
https://www.youtube.com/watch?v=oY_9hKdTG8o&feature=youtu.be

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**Analyse/Communicate/Reflect**

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<tr>
<th>S</th>
<th>What did you discover? Discuss and come to conclusions.</th>
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<tbody>
<tr>
<td>1.</td>
<td>What is the actual source of a sound, in what does it originate?</td>
</tr>
<tr>
<td>2.</td>
<td>What vibrates in the 4 different types of tone generators?</td>
</tr>
<tr>
<td>3.</td>
<td>Is it necessary for the vibrating medium to be elastic? Why?</td>
</tr>
<tr>
<td>4.</td>
<td>Through what does the sound propagate until your ear?</td>
</tr>
<tr>
<td>5.</td>
<td>What this has to do with waves?</td>
</tr>
<tr>
<td>6.</td>
<td>In a sound wave: do the air particles really move? Or are they just compressed and decompressed?</td>
</tr>
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During this ‘contact moment’ the pupils reflect on what they learned. They present their conclusions to the teacher and the other pupils by answering to questions of the teacher (see questions in the central column as an example).
Create/Design

E/A

Build a simple idiophone (with a bottle filled with water), aerophone (with a bottle filled with water), chordophone (a box with a rubber band) and a membranophone (a box with a balloon wrapped around the top)

Reflect and communicate

1. What's always the cause of a sound? In what does it originate?
2. What vibrates in the 4 types of tone generators?
3. Is it necessary for the vibrating medium to be elastic, why?
4. Through which medium does the sound propagate to your ear?
5. How is this related to waves?
6. In a sound wave: do the air particles really move? Or are they just being compressed and decompressed?

Slide 16:

Students experience what they have learned about the sources of sound in a real musical-praxis environment.

Suggestions:
You can build the bottle as idiophone by partially filling the bottle with water: hit then the bottle with a stick to make sound.
You can build a bottle as aerophone by filling it partially with water: blow then in the bottle to obtain sound.
Create/Design

A

Build a bottle organ and play with it.

Build a bottle organ
Pour water into a couple of bottles and find three different tones.

How to play: Place the bottle against your lower lip. Do not blow into the bottle, but blow over it while your airflow gently touches the sharp edge.

Slide 17:

Simple Musical Exercise 2

Suggestion:
when looking for the tones, it is useful to have a pupil which follows a music course in each group, whenever possible.

Create/Design

A

Build an idiophone with bottles and play it as a bell game.

Simple musical exercise 3

How to make a BOTTLE CHIMES

Material:
Water, big bottles without relief, wooden spoon, watering can, an instrument to help tuning.

Working method:
- Pour water into the bottles and search the right tone high by hitting them with the soon.
- Compare the tone with that of another tuned instrument: the tone becomes lower when you put more and more water into the bottles.
- Try to ‘make’ a tone scale.

Playing method:

Watch first the video as inspiration.

Bottle bell game
Watch the video and be inspired.

Musicate with question and reply.

Hit the bottles with a wooden spoon or rubber hammer. Change the water level and investigate what happens to the pitch.

A
<table>
<thead>
<tr>
<th>Put the bottles in the correct order on the table. Create now the most beautiful melodies with the wooden spoon!!</th>
</tr>
</thead>
</table>
| **Now play music:**  
Now you can create a melody by two. For example by asking a musical question and someone else can than give the musical answer. Use the video as inspiration. |