AUDIOMETRY

The aim of the practical

The purpose of this exercise is to test hearing loss at different frequencies for air and bone conduction.

Equipment

Audiometer AD226 (Interacoustics) with bone and air conduction headphones.

1. Power switch
2. Screen displaying the result of right ear (red graph) and left ear (blue graph) examination.
3. The sound level that is presented for the right ear is displayed here. The icon  is also displayed here when the sound is applied.
4. The tone frequency is displayed here. Additionally, the green indicator 

shows up when the examined person presses report button.
5. Sound pressure level jump switch. Should be set to **5dB**.
6. Change in the frequency of the presented tone: decrease (6a) or increase (6b).
7. Choosing the right ear.
8. Choosing the left ear.
9. Switch for bone conduction test. The light above shows the currently tested ear (R - right; L - left).
10. Mark a specific point on the graph while performing the test.
11. The knob changing sound level.
12. Button for manual presentation of a given tone.
13. Removal of the current point from the graph. Pressing together with the **shift** button clears the entire graph.
14. Turns on a noise applied to the opposite ear.
15. Reporting button - the examined person use it to signal audible sound.
16. Headphone for bone conduction testing.
17. Headphone for air conduction testing. Red color - right ear, blue color - left ear.
18. Shift button.
19. Button changing the mode of tone presentation (Man - manually using the gray button; or Rev - automatically)
20. Noise level knob.

Following tests will be carried out for each person in the group:
A. Examination of air conduction hearing loss,
B. Examination of air conduction hearing loss when noise is applied to the opposite ear,
C. Examination of bone conduction hearing loss,

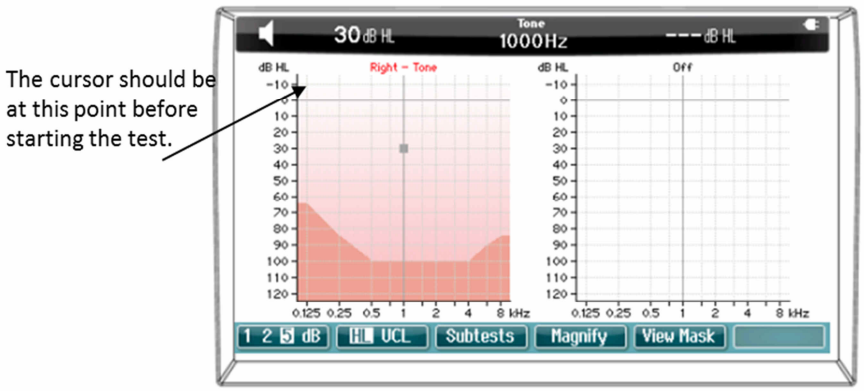
A. Examination of air conduction hearing loss

Course of the Part A:

1. Switch on the audiometer with button **(1)**.
2. Before starting the test:

- use the button **(5)** set the step of the tone intensity level change to 5dB (the value is visible on the screen above the button);
- activate the examination of the right ear with the red button **(7)**; the **Right** lamp should light up;
- activate the continuous tone presentation mode with the button **(19)**; the **Rev** lamp should light up;

3. In the upper left corner of the screen, the currently set value of sound intensity is shown (red frame in the figure below), while in the middle of upper part of the screen the value of frequency is shown (green frame in the figure). Additionally, the screen shows a graph with the frequency and sound intensity. A gray square cursor indicates intensity and frequency of currently presented tone. When the right ear is tested, the red graph is visible, while when the left ear is tested, the blue graph is highlighted. Using the **Frequency buttons (6a, 6b)** set the frequency equal to 0.125 kHz. Then use the **knob (11)** to set the tone intensity level to the lowest possible value, i.e. -10 dB HL.



4. The examined person puts on air headphones **(17)** so that the auricles are inside the sealing rings. There should be a blue headphone on the left ear.
5. The sign  visible in the upper left corner of the display confirms that the tone is presented. The examiner, using the signal amplitude adjustment knob **(11)**, increases the sound intensity level every few seconds (one step forward increases this value by 5 dB). Examined person presses the reporting button when the tone become audible. The examiner is informed about it by the appearance of a green rectangle 

in the upper part of the screen. The hearing threshold value for a given frequency should be marked on the graph by pressing the yellow **Store button (10).** It is important that the examined person does not look at the apparatus and cannot see the parameters of presented tone.
6. After pressing the **Store** button **(10)** in the previous point of the manual, the level of the presented sound intensity should decrease to -10 dB, and the frequency should increase to the next available value.We repeat the measurement for the following frequencies: 125Hz, 250Hz, 500Hz, 750Hz, 1kHz, 1.5kHz, 2kHz, 3kHz, 4kHz, 6kHz, 8kHz. Always save the hearing threshold by pressing the yellow button **Store (10)**.
7. After examining all available frequencies, fill the table in the form and mark all obtained points on the graph in red, connect them with a line. We recommend to use a standardized audiometry point markings.

	conduction	unmasked	with noise
Right ear	air	○	△
	bone	<	[
Left ear	air	×	□
	bone	>	]
No response		↓	↓

8. Repeat steps 2-7 for the left ear. The blue button **(8)** is used to switch the tone presentation to the left ear; the **Left** lamp should light up and a blue graph should apear. Do not change the position of the headphones!
9. Before proceeding to further measurements, obtained curves should be deleted, to do this press the **Shift (18)** and **Del Point (13)** buttons together.

B. Examination of air conduction hearing loss when noise is applied to the opposite ear

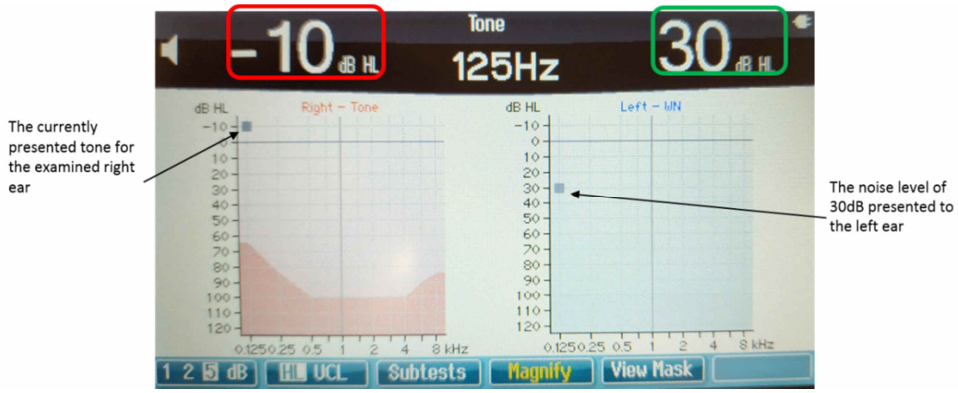
In this part, the hearing loss is examined when the 30dB white noise is presented to the opposite ear. In this mode, it is possible to test whether the hearing loss in a given ear is masked by hearing the tone with the opposite ear.

Course of the Part B:

10. Before starting the test:

- use the button **(5)** set the step of tone intensity level change to 5dB (the value is visible on the screen above the button);
- activate the examination of the right ear with the red button **(7)**; the **Right** lamp should light up;
- activate the continuous tone presentation mode with the button **(19)**; the **Rev** lamp should light up;
- turn on the presentation of noise to the opposite ear with the **Mask on / off button (14)**, the lamp above the button should light up.

11. There are two graphs on the screen. Red "Right - Tone", which shows the parameters of the tone presented to the examined right ear. Blue "Left - WN" with the value of the frequency and intensity of the noise presented to the left ear. White noise is presented, hence the name WN. Use the **right knob (20)** to set the noise level to 30dB (the green frame in the figure below show noise level).
12. Using the **Frequency buttons (6a, 6b)** and the **knob (11),** set the frequency of the tone presented to the tested right ear to 0.125 kHz, and the tone intensity level to the lowest possible value, i.e. -10 dB HL (red frame on figure below).



13. The examined person puts on air headphones (17). There should be a blue headphone on the left ear.
14. The sign  visible in the upper left corner of the display confirms that the tone is presented. The examiner, using the signal amplitude adjustment knob **(11)**, increases the sound intensity level every few seconds. Examined person presses the reporting button when the tone become audible. The examiner is informed about it by the appearance of a green rectangle 

in the upper part of

the screen. The hearing threshold value for a given frequency should be marked on the graph by pressing the yellow **Store button (10).** It is important that the examined person does not look at the apparatus and cannot see the parameters of the presented tone.

15. After pressing the Store button (10) in the previous point of the manual, the level of the presented sound intensity should decrease to -10 dB, and the frequency should increase to the next available value. Repeat the measurement for the following frequencies: 125Hz, 250Hz, 500Hz, 750Hz, 1kHz, 1.5kHz, 2kHz, 3kHz, 4kHz, 6kHz, 8kHz. Always save the hearing threshold by pressing the yellow button **Store (10).**
16. After examining all available frequencies, fill the table in the form and mark obtained points on the graph, connecting them with a line. We recommend to use standardized audiometry point markings.
17. The left ear should be examined using a similar procedure. The blue button **(8)** is used to switch the tone presentation to the left ear; **Left** lamp should light up. After pressing it, the graph captions on the screen will change. The right red graph will be titled "Right - WN" and this graph will show the noise level presented to right ear which should be set to 30dB using knob **(20)**. The left blue graph will be titled "Left - Tone" and this graph shows the intensity and frequency of the tone presented to the left ear being tested. Using the **Frequency buttons (6a, 6b)** and the **knob (11)**, set the frequency of the tone presented to the tested ear again as 0.125 kHz, and the tone intensity level to the lowest possible value, i.e. -10 dB HL.
18. Fill the table in the form and mark obtained points on the graph, connecting them with a line
19. Before proceeding to further measurements, obtained curves should be deleted, to do this press the **Shift (18)** and **Del Point (13)** buttons together.

C. Examination of bone conduction hearing loss

In this part, a bone conduction will be examined. Acoustic tone is conducted also through the solid body - the bones of the skull, and directly stimulates the cochlea bypassing the outer and middle ear. In this study, the air headphone is placed on the left or right mastoid process above the ear. The measurement is performed as in point A.

Course of the Part C:

20. Before proceeding to further measurements, obtained curves should be deleted, to do this press the **Shift (18)** and **Del Point (13)** buttons together.
21. The examined person puts on the bone conduction headset **(16)** so that the disc-shaped conductor (with cable) is placed on the mastoid process of the right temporal bone (just behind the ear). The second end of the headset should be placed opposite to the frontal bone (it is only used to stabilize the bone handset).
22. Turn on the bone conduction measurement with green button **(9),** and set the measurement to the right ear (press button **9** till the **R** lamp above the button will light up).
23. The measurement is analogous as for air conduction (part A) except the frequency range that is between 250 and 8000Hz.
24. In order to change the tested ear to the left one, press again the green button **(9)** so that the **L** lamp above the button 8 will light up. Change the position of the bone conductor to the left mastoid process.
25. Rewrite the obtained points into the table and mark them on the graph, connect points with a line.

Required theoretical knowledge

1. Physical description of waves, acoustic waves. Audible, infra- and ultra- sounds.
2. Hearing and pain thresholds, equal-loudness contour
3. Acoustic pressure, sound intensity, sound intensity level, pitch and timbre of sound.
4. Weber-Fechner law (the decibel scale and phonon scale, level of loudness and loudness).
5. Mechanism of sound recognition by human ear. Transformation of mechanical vibrations in electrical signals in the organ of Corti.
6. Air and bone conductance of sound.
7. Audiometry

Recommended literature

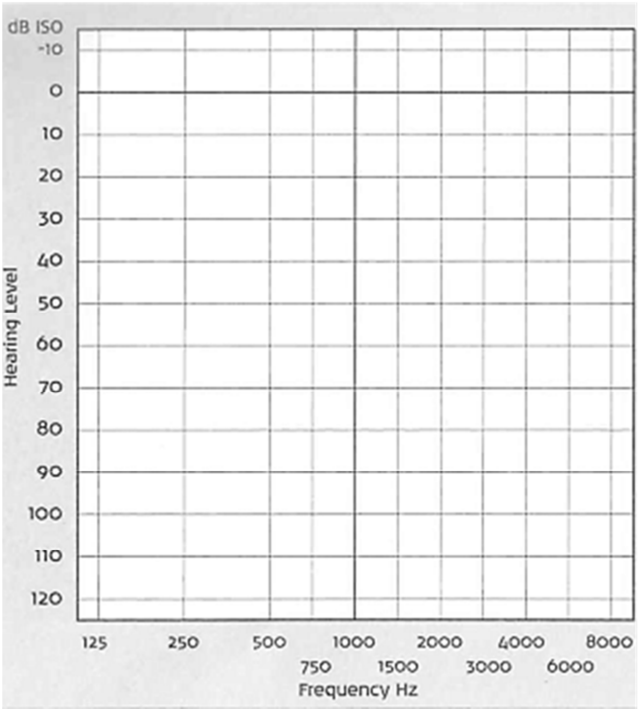
1. Roland Glaser, “Biophysics, an introduction”, Springer 2012. (chapter 4.3)
2. P. Davidovits, “Physics in Biology and Medicine”, Elsevier, 2001. (chapter 12)

Wroclaw Medical University Department of Biophysics and Neuroscience	**Practical No 25** **Audiometry**
…… …… ……..……... Students` names	Faculty: …… Group: …… Date: ……
Grade:	Tutor`s signature

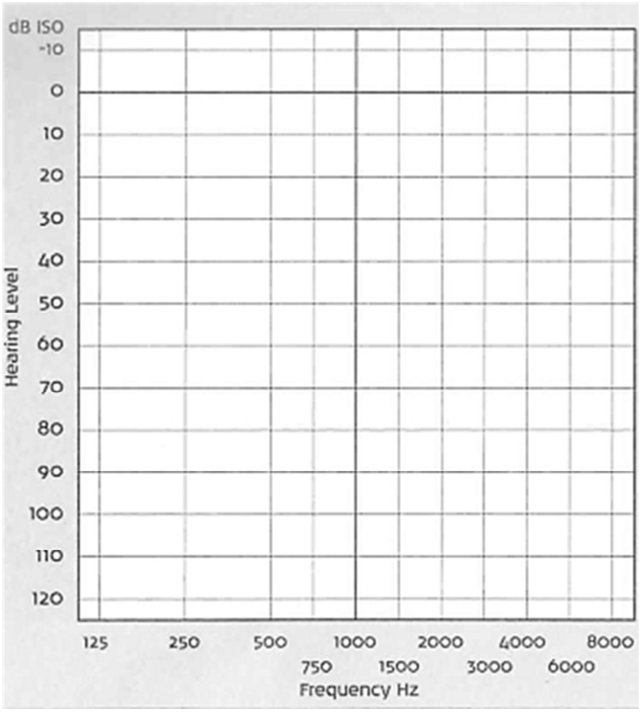
Student 1.

	Hearing loss for the **right ear**			Hearing loss for the **left ear**		
Frequency [Hz]	Air conduction [dB HL]	Air conduction with noise [dB HL]	Bone conduction [dB HL]	Air conduction [dB HL]	Air conduction with noise [dB HL]	Bone conduction [dB HL]
125						
250						
500						
750						
1000						
1500						
2000						
3000						
4000						
6000						
8000						

Left ear



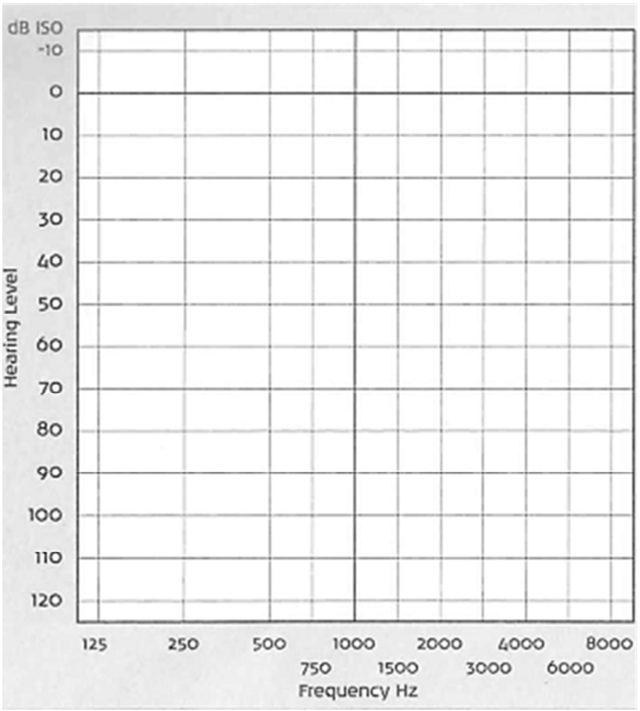
Right ear



Student 2.

	Hearing loss for the **right ear**			Hearing loss for the **left ear**		
Frequency [Hz]	Air conduction [dB HL]	Air conduction with noise [dB HL]	Bone conduction [dB HL]	Air conduction [dB HL]	Air conduction with noise [dB HL]	Bone conduction [dB HL]
125						
250						
500						
750						
1000						
1500						
2000						
3000						
4000						
6000						
8000						

Left ear



Right ear