

## **M5\_on-line. The basics of biophysics of the hearing sense. Testing the human ear threshold of audibility**

### **Topics:**

- Mechanical vibrations.
- Mechanical waves – creation, propagation, properties and equation of harmonic wave motion.
- The wave interference phenomenon and the stationary wave.
- The acoustic wave as an example of mechanical wave, acoustic wave properties, acoustic wave equation, the isophonic contours.
- The resonance phenomenon.
- Weber-Fechner law.
- Doppler effect.
- The ear and hearing. The audibility threshold and the threshold of pain.
- Objective and subjective audiometry.
- Sound features and the intensity of sound.

### **Sound Intensity Terms:**

Sound Intensity is the average sound energy flux flowing through a specific area - the product of the sound pressure and the particle velocity.

Sound Intensity (I) is a vector quantity, having both magnitude and direction of the sound energy flow.

Sound Intensity Level is the logarithmic ratio of the measured sound intensity to the reference sound intensity in decibels.

The Sound Intensity Level Formula:  $\text{dB}[\text{decibel}] = 10 \log (I/I_0)$ , where I is the sound intensity in  $\text{W/m}^2$  and  $I_0$  is the reference sound intensity of  $10^{-12} \text{ W/m}^2$ .

### **Description of experiment:**

The goal of the experiment is determination of the human ear threshold of audibility for acoustic waves of varying frequencies (from 250 to 8000 Hz). The thresholds of audibility might be determined with air and bone conductance audiometry.

In the air conductance audiometry the test signal is transmitted through headphones and Hughson Westlake's test is applied. It is an automatic tonal test. The threshold of audibility is defined as 2 out of 3 correct responses to the same intensity and frequency of generated tone.

In the automatic procedure the tone intensity is increased by 5 dB or decreased by 10 dB. The goal of audiometry is determination of the threshold of audibility for various frequencies. The examination might reveal hearing defect, but it cannot specify its reason.

In the bone conductance audiometry the bone vibrator is used to apply test signal to either mastoid process or to a forehead of a patient. The idea is to transfer the tone directly to the inner ear and determine the threshold of audibility of the inner ear. In this test the second ear should almost always be masked.

**Instruction:**

1. Teacher provides a fulfilled audiogram.
2. Analyze a data on the audiogram. Compare types of conductance for a given ear and the same types of conductance for different ears. Indicate the trends if any. Try to find a data for a 'healthy' person and refer to it.
3. Calculate the sound intensity for frequency  $f = 1000$  Hz for both ears and both types of conductance. Assume standard human threshold of hearing as reference.

