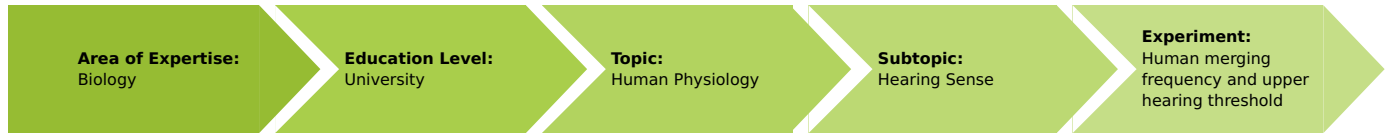


# Human merging frequency and upper hearing threshold

(Item No.: P4040101)

## Curricular Relevance



### Difficulty



Intermediate

### Preparation Time



10 Minutes

### Execution Time



1 Hour

### Recommended Group Size



2 Students

### Additional Requirements:

### Experiment Variations:

### Keywords:

Acoustic hearing thresholds, Merging frequency, Hearing range, Sine wave generator

## Overview

## Principle

### Theory

The human ear perceives sounds only within a very specific frequency range. Animals also have a typical hearing range, and even vertebrates may have ranges differing very considerably from the human range:

- goldfish up to 4 kHz
- frog 30 Hz to 15 kHz
- chaffinch 200 Hz to 29 kHz
- cat up to 50 kHz
- bat up to 90 kHz
- whale up to 150 kHz

In man, the upper acoustic threshold depends greatly on age. The mean values for the measurements undertaken should correspond roughly to the values in the following table:

- up to:16 years 20 kHz
- 20 years 18 kHz
- 35 years 15 kHz
- 50 years 12 kHz
- 70 years 9 kHz
- 90 years 5 kHz

### Principle

The hearing range of the human depends greatly on age. While tones above the upper acoustic threshold are not perceived at all, individual sounds under the lower hearing threshold are perceived as a continuous deep tone (merging).



Fig. 1: Experimental set-up

## Equipment

Position No.	Material	Order No.	Quantity
1	PHYWE Digital Function Generator, USB, incl. Cobra4 software	13654-99	1
2	Headphone, stereo	65974-00	1

## Tasks

- Determine the merging frequency and upper acoustic threshold of test subjects of various ages.
- Stimulate the ear with tones at the lower and upper acoustic threshold using a sine wave generator and headphones.

## Set-up and procedure

### Set-up

- The digital function generator is set up and switched on in a room that is as quiet as possible. Set the function to sine and frequency to 20 kHz. Change the output to headphones, connect the headphones, and set the signal amplitude to maximum.
- Place the headphones on the head of the test subject.

### Procedure

- The leader of the experiment gradually reduces the frequency until the test subject just hears the sound. The measurement is recorded. To prevent personal influence, the test subject must not be able to see the digital display during the measurement procedure. The measurement should be repeated several times with the same test subject.
- The frequency is set to 10 Hz. The leader of the experiment gradually increases the frequency until, according to the test subject, the individual sounds merge into a continuous tone. This merging frequency is recorded. The measurement is repeated several times with the same test subject.
- The upper acoustic threshold and merging frequency should, for comparative purposes, also be determined in younger and older test subjects according to the procedure described above.
- The use of a loudspeaker instead of headphones certainly has the advantage that the measurement can be carried out on many test subjects simultaneously, but the method is not recommended since standing waves form in the experimental room. As a result, with a constant frequency and amplitude the tone is heard with different degrees of loudness depending on whether the ear is near a wave centre or near a wave node.

## Results and Evaluation

### Result

When the upper acoustic threshold is exceeded there is no longer any stimulation of the sensory cells even with maximum sound intensity. When the lower limit is undershot, however, individual sounds remain audible. Nevertheless, the lower acoustic threshold can readily be determined since in this case the individual sounds change to a continuous deep tone (merging); it is thus best termed the merging frequency. This frequency is independent of age and lies between 16 and 20 Hz.