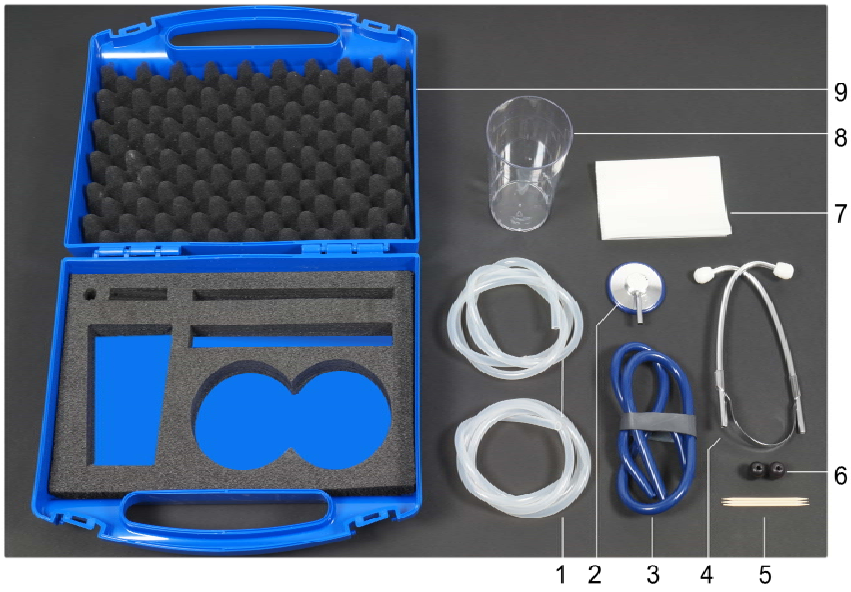
Equipment Set Stereophonic Hearing 1018551

Instruction manual

03/15 TL/UD



1 Tubing, 1 m
Tubing, 0,5 m (2)
2 Stethoscope probe
3 Stethoscope tube
4 Stethoscope headset with earpieces
5 Wooden stick
6 Spare earpieces
7 Tracing paper
8 Plastic beaker
9 Storage case

1. Safety instructions

Safe operation of the apparatus can be guaranteed as long as it is used as stipulated. Safety cannot, however, be assured if the equipment is used incorrectly or carelessly.

2. Equipment in set

1 Stethoscope with probe, tubing, headset and earpieces
1 Tubing 1 m
2 Tubing, 0.5 m
5 Wooden sticks
1 Pair of spare earpieces
2 Piece of tracing paper 15x15 cm^2
1 Plastic beaker
1 Storage case

3. Technical data

Dimensions	
Storage case:	28x25x10 cm approx.
Weight (complete):	675 g approx.

4. Description

The equipment set allows for investigation of directional hearing and determination of the differences in the time it takes sound to travel to the left ear and right ear by making tapping sounds on a closed tube. For the purpose of comparison, the difference in time for sound to travel to two microphone probes 4008308 can be measured using a microphone box 1014520/1014521 and a microsecond counter 1017333/1017334 or with an oscilloscope, e.g. 1018581. This makes it possible to measure the speed of sound. The effect of linear distortion on directional hearing is investigated with the help of cavity resonance where open ends of two tubes are dipped into a beaker half filled with water either simultaneously or in alternation.

5. Operation/Sample experiments

5.1 Determining differences in time for sound to travel to right and left ears

Required equipment:

1 Stereophonic hearing equipment set 1018551

- Mark the centre of the 1-m tube with a suitable pen.
- Connect both ends of the 1-m tube to the stethoscope headset.
- Person A wears the stethoscope in such a way that the tube forms a loop on their back.
- Person B uses a wooden stick to tap on the tube, initially precisely on the mark in the middle and then tapping again, varying the distance away from the centre by a few centimetres each time.
- Person A makes a signal whenever they think the tapping came from anywhere other than the centre of the tube and the direction in which it was shifted.
- Person B measures the distance Δs from the centre at which Person A has been able to detect the difference.
- Calculate the time it takes sound to reach the right and left ears when the location of the tap is moved to the left:

$$T_{\pm} = \frac{0.5\,\text{m} \pm \Delta s}{c}$$, +/–: right ear/left ear

c: speed of sound

Note:
When the position of the tap is moved to the right, the positive sign refers to the time to reach the left ear and the minus sign to the time to reach the right ear.

- Calculate the difference between the time it takes sound to reach the right and left ears (c = 343 m/s at 20°C):

$$\Delta T = T_{+} - T_{-} = \frac{2 \cdot \Delta s}{c}$$

Human hearing can perceive time differences of millisecond magnitude.

5.2 Determining differences in time for sound to travel to two microphone probes, with the help of a microsecond counter, and determination the speed of sound

Required equipment:

1	Stereophonic hearing equipment set	1018551
2	Microphone probes, short	4008308
1	Microphone box (@230 V)	1014520
or		
1	Microphone box (@115 V)	1014521
1	Microsecond counter (@230 V)	1017333
or		
1	Microsecond counter (@115 V)	1017334
2	HF patch cords BNC/4-mm plugs	1002748
1	Ruler, 1 m	1000742

- Mark the centre of the 1-m tube with a suitable pen.
- Insert each of the two microphone probes about 1.5 cm into the ends of the 1-m tube and use the metre ruler to ensure that the mid-point between them is at the 50 cm mark on the ruler, which should also coincide with the centre of the tube, as already marked (Fig. 1).
- Connect the left-hand microphone probe to channel A of the microphone box and right-hand one to channel B.
- Set the gain for both the microphone box channels to the maximum and set the outputs to trigger (_⊓_).

Note:
Make sure noise from the surroundings is kept to a minimum, since this could lead to erroneous results due to the gain being set to its maximum level. If necessary, turn the gain down a little bit.

- Connect one HF BNC/4-mm-plug patch cord/adapter lead to the channel A output of the microphone box. Connect the red 4-mm plug to the Start input of the microsecond counter (green 4-mm safety socket). Connect the black 4-mm plug to the ground of the microsecond counter (black 4-mm safety socket).
- Connect the other HF BNC/4-mm plug adapter lead to the channel B output of the microphone box. Connect the red 4-mm plug to the Stop input of the microsecond counter (red 4-mm safety socket). Connect the black 4-mm plug to the ground of the microsecond counter (black 4-mm safety socket).
- Connect the microphone box and the microsecond counter to the mains via their accompanying plug-in power supplies.
- Use the wooden stick to tap on the marked point in the middle of the tube. The microsecond counter should display “0000” µs, since the signals take equal amounts of time to reach the two microphone probes.
- Gradually move the position where you tap the tube leftward by distances Δs relative to the mark in the centre. The times ΔT as measured by the microsecond counter correspond to the difference in the times taken to reach the left-hand and right-hand micro-

phones. It may be a good idea to repeat the individual measurements and take the average values.

Note:
Moving the tapping position to the right would make no sense due to the fact that the left-hand microphone is connected to the start function and the right-hand is associated with the stop function.

- Plot the relative distances Δs against the time differences ΔT and draw a straight line which fits the measurement points (Fig. 2). Determine the speed of sound from the gradient using the following equation:

$$c = 2 \cdot \frac{\Delta s}{\Delta T} = 2 \cdot 164 \frac{\text{m}}{\text{s}} = 328 \frac{\text{m}}{\text{s}}$$

The value measured only differs by about 4% from the value quoted in tables, 343 m/s (at 20°C).

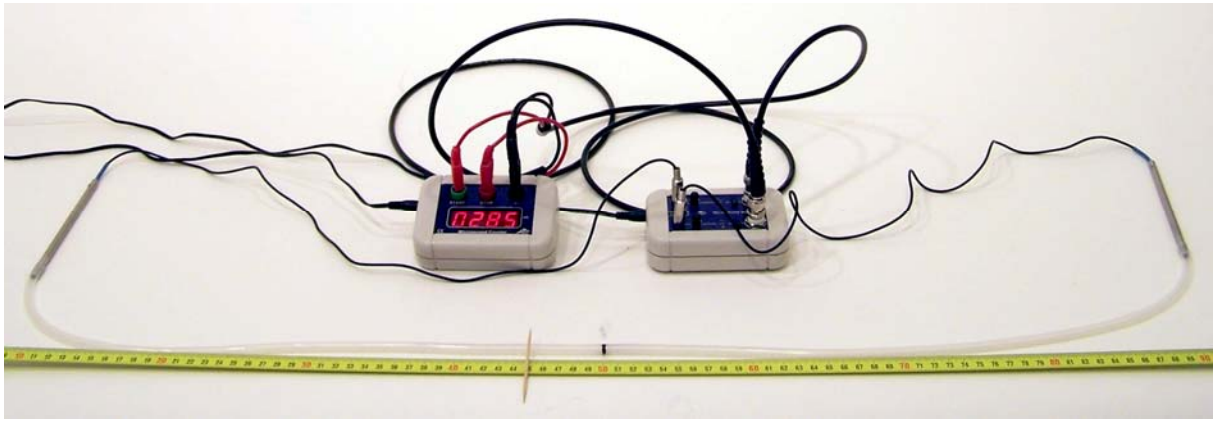


Fig. 1: Measurement of difference in time for sound to reach two microphones using the microsecond counter.

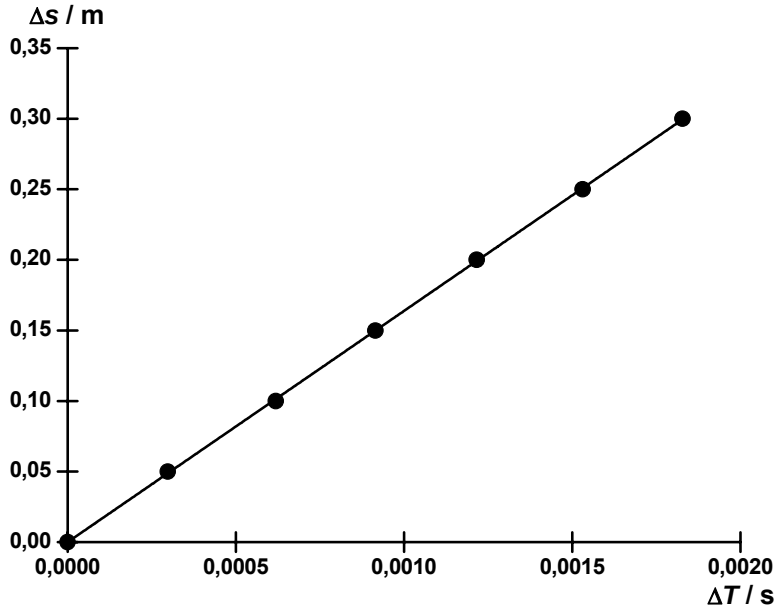


Fig. 2: Relative distances plotted as a function of time differences with a fitted straight line for determining the speed of sound in air.

5.3 Measurement of differences in time for sound to travel to two microphone probes, with the help of an oscilloscope, and determination the speed of sound

Required equipment:

1	Stereophonic hearing equipment set	1018551
2	Microphone probes, short	4008308
1	Microphone box (@230 V)	1014520
or		
1	Microphone box (@115 V)	1014521
1	Digital oscilloscope, 2 x 25 MHz	1018581
2	HF patch cords	1002748
1	Ruler, 1 m	1000742

- Mark the centre of the 1-m tube with a suitable pen.
- Insert each of the two microphone probes about 1.5 cm into the ends of the 1-m tube and use the metre ruler to ensure that the mid-point between them is at the 50 cm mark on the ruler, which should also coincide with the centre of the tube, as already marked (Fig. 1).
- Connect the left-hand microphone probe to channel A of the microphone box and right-hand one to channel B.
- Set the gain for both the microphone box channels to the maximum and set the outputs to trigger (_⊓_).

Note:
Make sure noise from the surroundings is kept to a minimum, since this could lead to erroneous results due to the gain being set to its maximum level. If necessary, turn the gain down a little bit.

- Connect one HF patch lead to channel CH1 of the oscilloscope and the other one to channel CH2.
- Connect the microphone box and the oscilloscope to the mains via their accompanying plug-in power supplies. Example oscilloscope settings: 25 μs/div, horizontal position: 200.0 μs, Vertical deflection: 5.00 V/div DC, run control: single, trigger: edge, mode: single, level 1.60 V approx.
- Use the wooden stick to tap on the marked point in the middle of the tube. The signals from the two microphone probes should coincide on the oscilloscope screen, since the signals take equal amounts of time to reach the two microphone probes.
- Gradually move the position where you tap the tube leftward or rightward by distances Δs relative to the mark in the centre. Read off the difference in the times ΔT taken to reach the left-hand and right-hand microphones as the distance along the horizontal axis of the oscilloscope between the two rising edges. It may be a good idea to repeat the individual measurements and take the average values.

Notes:
When the tapping position is a long way from the centre of the tube, choose a suitably large time base for the oscilloscope and set the horizontal position accordingly.

Before each new measurement, press the Run/Stop button on the oscilloscope.

- Plot the relative distances Δs against the time differences ΔT and draw a straight line which fits the measurement points. Determine the speed of sound from the gradient using the following equation:

$$c = 2 \cdot \frac{\Delta s}{\Delta T}.$$

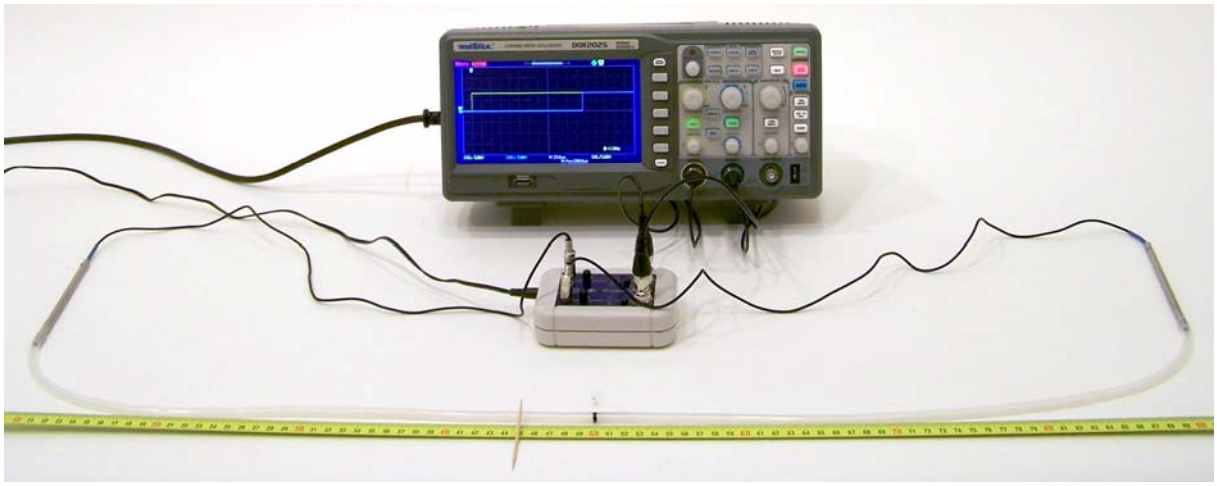


Fig. 3: Measurement of difference in time for sound to reach two microphones using an oscilloscope.

6. Storage, cleaning and disposal

- Store the equipment in a clean, dry and dust-free location.
- Do not use aggressive cleaning agents or solvents to clean the equipment.
- Use a soft, damp cloth for cleaning purposes.
- The packaging should be disposed of at local recycling points.
- Should you need to dispose of the equipment itself, never throw it away in normal domestic waste but use containers specifically set aside for electrical waste. Local regulations will apply.