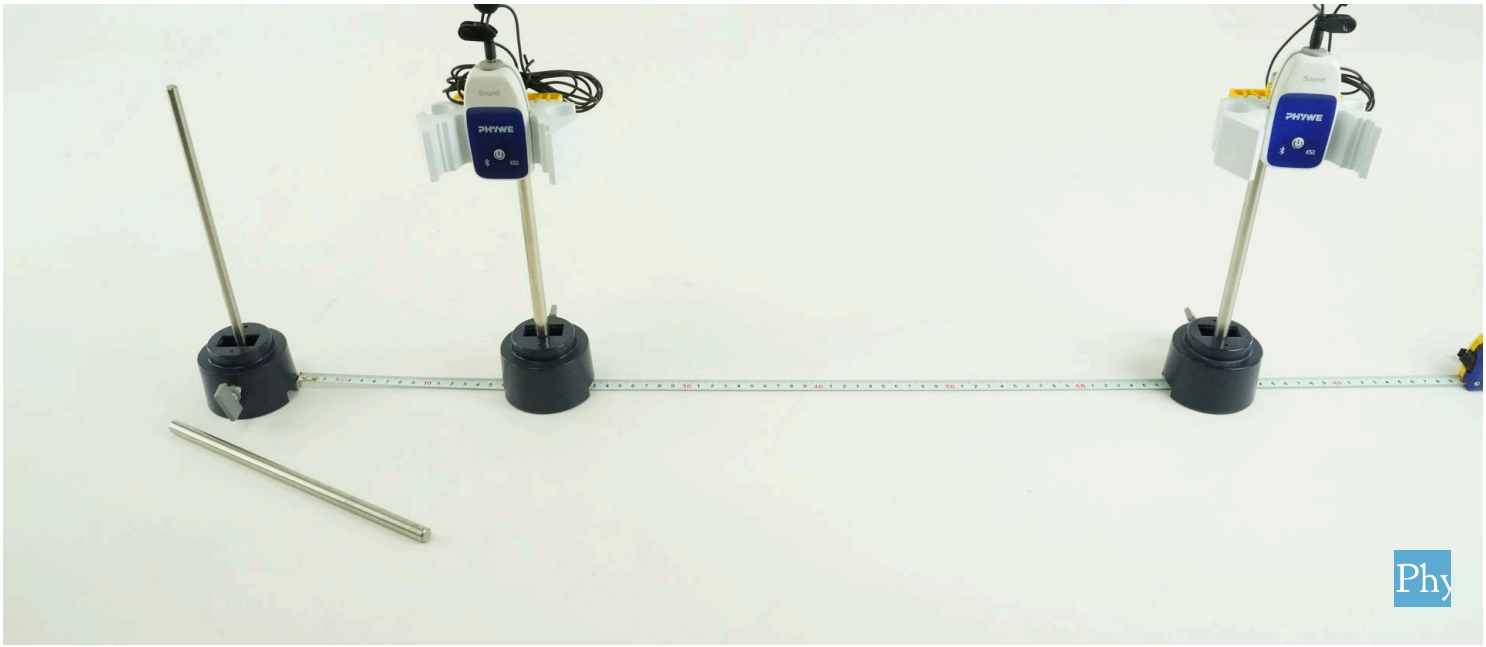
# Determination of velocity of sound in air with Cobra SMARTsense



| | | | |
|---|---|---|---|
| Physics | Mechanics | Vibrations & waves | |
| Physics | Acoustics | Sound generation & propagation | |

| Difficulty level | Group size | Preparation time | Execution time |
|---|---|---|---|
| - | - | - | - |

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# General information

## Application

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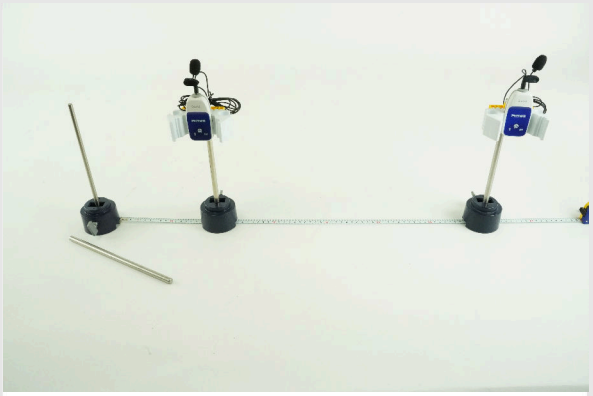

Setup

The speed of sound describes the velocity with which vibrations are propagated in a medium. Specificly the speed of sound in air can be used for echolocation and is also very relevant in fields like aviation.



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## Other information (1/2)

**Prior knowledge**

The fundamental relationship between velcity, distance and time v = d / t.

**Main principle**

The velocity of sound in air is determined by measurements of sound travel times.

## Other information (2/2)

**Learning objective**

The goal of this experiment is to determine the velocity of sound in air.

**Tasks**

1. Determine the speed of sound in air.



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## Equipment

| Position | Material | Item No. | Quantity |
|---|---|---|---|
| 1 | Cobra SMARTsense - Sound (Bluetooth + USB) | 12939-00 | 2 |
| 2 | Holder for Cobra SMARTsense | 12960-00 | 2 |
| 3 | USB charger for Cobra SMARTsense and Cobra4 | 07938-99 | 1 |
| 4 | measureAPP - the free measurement software for all devices and operating systems | 14581-61 | 1 |
| 5 | Support rod, stainless steel, l = 250 mm, d = 10 mm | 02031-00 | 4 |
| 6 | Barrel base expert | 02004-00 | 3 |
| 7 | Measuring tape, l = 2 m | 09936-00 | 1 |



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# Setup and Procedure

## Setup (1/2)

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The Cobra SMARTsense Photogate and measureAPP are required to perform the experiment. The app can be downloaded for free from the App Store - QR codes see below. Check whether Bluetooth is activated on your device (tablet, smartphone).

measureAPP for Android operating systems

measureAPP for iOS operating systems

measureAPP for Tablets / PCs with Windows 10



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## Setup (2/2)

The experimental set-up is shown in Fig. 1. Pay attention to the position of the lone rod, since it has to be in line with the two microphones.

Connect the sound sensors with the measurment software.

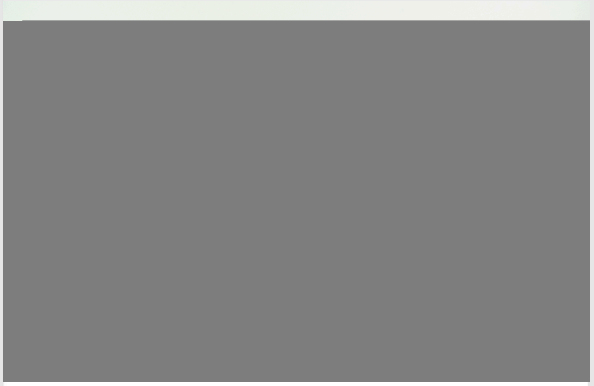

Fig. 1

## Procedure

After pressing the icon in the center bottom to start the measurment, hit the affixed rod with an additionell rod. By comparing the position of the two signals measured by the two microphones determine the travel time.

Determine the speed of sound with the measured travel time and the distance between the two microphones.

Repeat the experiment with multiple distances.



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# Evaluation

## Task 1

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A typical measurement series for the distance s = 0.3 m is given in Table 1:

The mean speed of sound is thus 338.0(4) m/s.

The speed of sound is constant for various microphone-sound source distances. Thus, sound propa-gates itself with constant velocity. In the literature one finds the following value for the speed of sound at 0° C: $c_0$ = 331.8 m/s, with the temperature dependence given by the following:

$$c(T) = c_0 \cdot \sqrt{\frac{T}{273}}$$

When the measurement shown here was performed, the ambient temperature was 18° C. The speed of sound for this temperature is calculated to be c = 342.6 m/s.

| v [m/s] |
|---|
| 338.448 |
| 338.438 |
| 338.753 |
| 337.230 |
| 337.258 |

Table 1



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