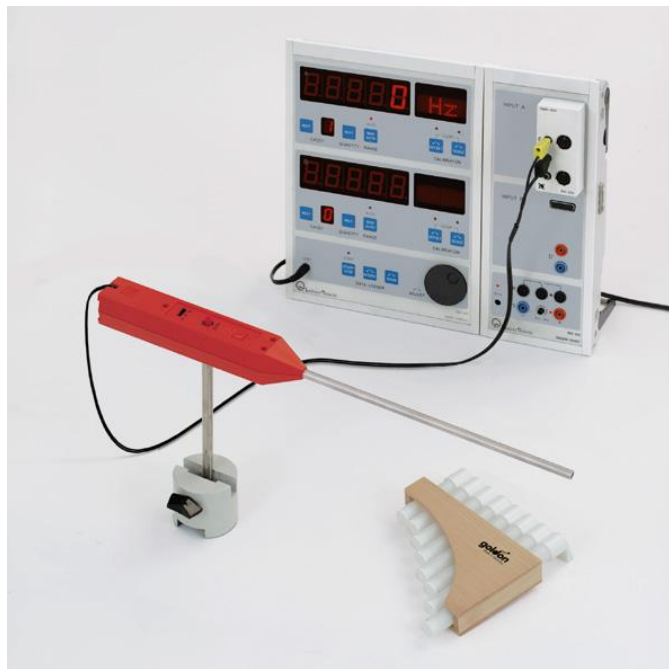


Acoustics  
Pitch and volumeRelationship between pitch and frequency -  
Measurement with Sensor-CASSY and CASSY-Display

## Objects of the experiments

1. Investigating the relation between the pitches and frequencies when the individual pipes of panpipes are blown
2. Investigating the relation between the lengths of the pipes of panpipes and the frequencies of the notes

## Setup



Microphone settings:

Output signal: pulse  $\square$ 

Gain: maximum

Battery: maximum charge is required ( $U \approx 9V$ )

Preparing the frequency measurement:

- Put the CASSY-Display into operation with the Sensor-CASSY being connected.
- Plug the timer box into Input A.
- Connect the microphone to Input E of the timer box and switch it on.
- Set the display of Input A to the measurement quantity Frequency (Hz) with the key NEXT (QUANTITY).
- Switch the display of Input B off with the key NEXT (CASSY).

Remarks concerning the frequency measurement:

In order to achieve good measuring results, the panpipes have to be blown neatly and each note has to be held for several seconds.

The individual pipes should be numbered consecutively before the measurement is started.

## Apparatus

1 Multi-purpose microphone .....	586 26
1 Timer box .....	524 034
1 Sensor-CASSY 2 .....	524 013
1 CASSY-Display USB .....	524 020USB
1 Metal rule, 0.5 m long .....	460 97
1 Saddle base .....	300 11

## Carrying out the experiment

1. Relation between pitch and frequency:

- Blow pipe 1 of the panpipes and hold the note for several seconds.
- When the frequency is approximately constant, read it from the display, and take it down.
- Repeat the procedure with the pipes 2 to 8.
- By blowing the pipes 1 to 8 repeatedly, compare the individual notes with each other and with the measured frequencies (qualitative comparison).
- Determine the tones of the major scale from the measured frequencies.

2. Relation between the pipe length and the frequency:

- Measure the lengths  $\ell$  of the pipes with the metal scale, and take them down.
- Compare the pipe lengths with the frequencies measured in experiment 1.

## Measuring example

Pipe	Frequency $f$ in Hz	Pitch	Note	Pipe length $\ell$ in mm
1	525		c''	162
2	590		d''	145
3	660		e''	129
4	700		f''	122
5	780		g''	108
6	880		a''	96
7	980		h''	85
8	1058		sharp	c'''

## Evaluation

The sharper the note of a pipe, the higher its frequency.  
The higher the frequency of a note, the shorter the pipe.

Remarks:

The notes of the scale can be determined by means of the following table:

Frequency* $f$ in Hz	264	297	330	352	396	440	495	528
Note	c'	d'	e'	f'	g'	a'	h'	c''

\*international/harmonic

The frequency of the note of a closed pipe can be calculated from the velocity of sound  $c$  ( $c = 344$  m/s) and the length  $\ell$  of the oscillating air column (which approximately corresponds to

the pipe length of the panpipes):  $f = \frac{c}{4 \cdot \ell}$ .