Generating standing waves in front of a reflecting barrier

Objects of the experiment

- Generating standing waves in front of a reflecting barrier.
- Comparing the distances between two adjacent oscillation nodes or antinodes with the wavelength.

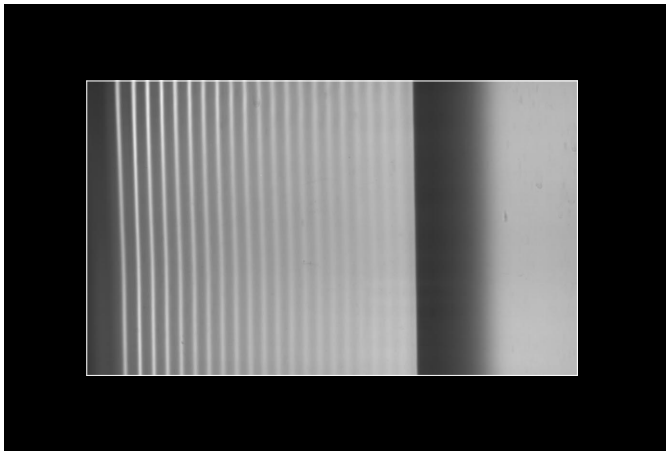
Principles

When two water waves of equal amplitude and frequency and opposing directions of propagation meet, they interfere with each other to create a *standing wave*, which does not propagate in any direction. A standing wave is created in the wave trough when straight water waves are reflected at a barrier running parallel to the exciter.

The standing wave demonstrates points at regular intervals at which the crests and troughs of the individual waves cancel each other out. These points are referred to as “nodes”. Within the oscillation period of the individual waves, we can observe two nodes; in front of and behind the nodes, the standing wave oscillates in phase opposition. The deflection is greatest at the midpoint between two nodes. These points are referred to as “antinodes”.

Although the two individual waves are continuous waves, the nodes and antinodes of the standing wave which they create do not change in their position.

Fig. 1 Generating standing waves in front of a reflecting barrier (photograph)



Apparatus

1 Wave trough with motor stroboscope . . .		401 501
1 Ruler or tape measure	e.g.	311 77

additionally required:

Dish soap

Setup

Set up the experiment as shown in Fig. 2.

– Set up the wave trough so that it is not subject to shocks and vibrations; observe all information given in the Instruction Sheet.

– Connect the exciter for straight waves as shown in Fig. 3; place the reflecting barrier within easy reach.

Carrying out the experiment

– If necessary, rotate the stroboscope disk out of the beam path using knurled screw **(f)** so that the glass pane in the bottom of the wave trough is completely illuminated.

– Using knob **(e)**, set a frequency of approx. 20 Hz, and carefully increase the excitation amplitude using knob **(d)** until wave fronts are clearly visible (see Instruction Sheet for wave trough).

– Vary the immersion depth of the exciter as necessary.

– To determine the wavelength, switch on the stroboscope with switch **(a)**; after a short warm-up time, you may need to carry out a fine adjustment of the excitation and stroboscope frequencies using knob **(b)** until an image of a standing wave appears.

– Measure the distance l between two wave fronts on the observation screen **(g)**. Be sure to take the image scale into consideration (see Instruction Sheet for wave trough).

– Switch off the stroboscope and set up the reflecting barrier parallel to the exciter in the right-hand side section of the wave trough.

– Observe the wave image.

– Measure the distance *d* between two nodes in front of the reflecting barrier on the observation screen (take the image scale into consideration) and compare this with the wavelength.

– Repeat the experiment for various excitation frequencies of 10 - 60 Hz; if necessary, carry out fine adjustment of the system. Keep the distance between the exciter and the reflecting barrier as great as possible for low frequencies and as small as possible for high frequencies.

Measuring example

Fig. 1 shows a photograph with a measuring example.

Tab. 1: Wellenlänge λ und Knotenabstand *d* stehender Wasserwellen in Abhängigkeit von der Erregerfrequenz *f*

$\frac{f}{\text{Hz}}$	$\frac{\lambda}{\text{cm}}$	$\frac{d}{\text{cm}}$
10	2.1	1.1
20	1.1	0.6
30	0.8	0.4
40	0.6	0.3
50	0.4	0.2
60	0.4	0.2

Results

Straight water waves and their reflections at a straight barrier interfere with each other in front of the reflecting barrier to form a standing wave. The positions of the oscillation nodes and antinodes do not change.

The distance between two adjacent nodes is one half the wavelength.

Standing waves can thus be used to measure the wavelengths.

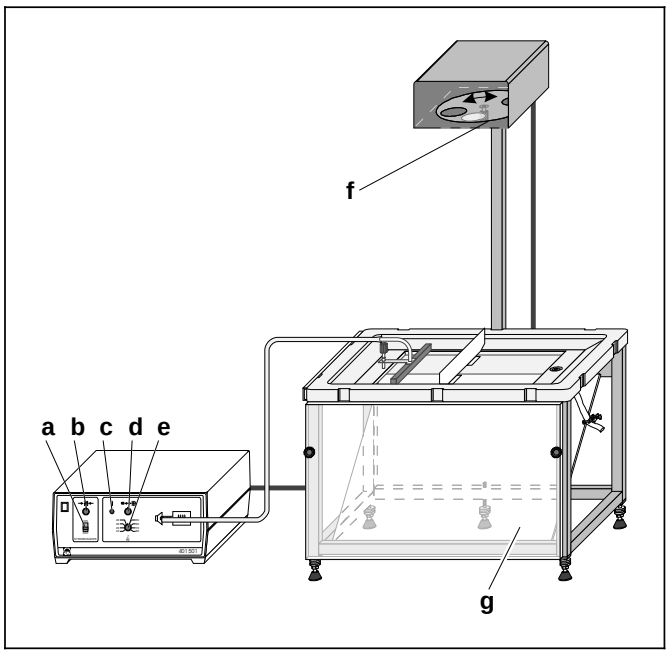
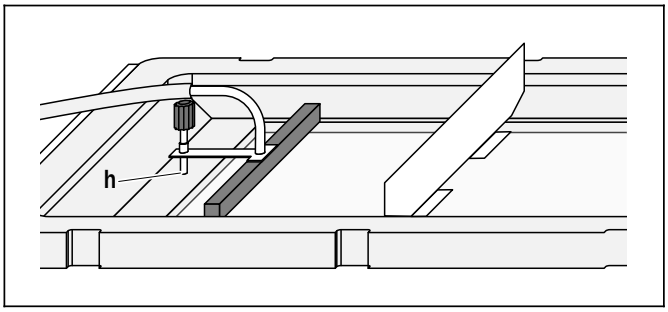


Fig. 2 Experiment setup for generating standing waves
a Stroboscope switch
b Knob (for fine adjustment of stroboscope frequency)
c Pushbutton (single-wave excitation)
d Knob (for adjusting amplitude of wave excitation)
e Knob (for adjusting frequency of wave excitation)
f Knurled screw (for manually turning stroboscope disk)
g Observation screen

Fig. 3 Connecting the exciter for straight waves
h Adjusting screw (for setting immersion depth)



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