

# THREAD PENDULUM - LARGE PENDULUM BALLS

SWD 01.01a



## Material:

Item Code	Qty	Description
DS600-10	1	Assembly for lab table "NTL"
DS600-6G	1	Board holders, pair, magnetic
DS500-1G	1	Screw clamp, jaw width approx. 50 mm
DS103-1P	1	Panel, green/white, 900x610mm
DS102-12	1	Stand rail base, L=125 mm
DS110-43	2	Magnetic base, d=43 mm, with tube and pin
DS200-04	1	Stand tube, H=40 mm
DS401-1B	1	Driving cord, loose, L=500 cm
DM380-6K	1	Ball, D=60 mm, plastics, white, tapped
DM386-1H	1	Pendulum ball with hook, wooden, D=60 mm
DG101-00	1	Ruler, metal, L=1000 mm
DE722-1W	1	Stop-watch "inno"
DE722-2W	1	Remote control for laser and stopwatch "inno"

The assembly can also be done as shown in the figure on the right:



# THREAD PENDULUM - LARGE PENDULUM BALLS

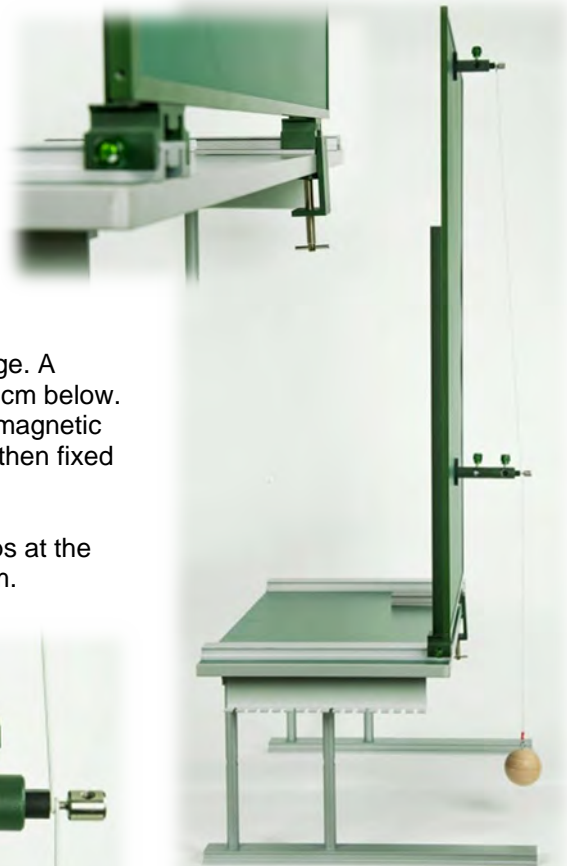
SWD 01.01a

## Goal:

Getting to know the terms periodic process, deflection and amplitude as well as the dependence of the period of oscillation on the length of the pendulum and on the mass of the pendulum bob

## Setup:

The table assembly is set up.  
About 45 cm from the left foot stringer profile, the 125 mm stand rail base is clamped with a screw clamp.  
The board holders are mounted on the front ends of the footrest profiles.  
The panel is attached to the board holders in an upright position.



One magnetic base is attached to the board approximately in the center, near the top edge. A second magnetic base is attached about 50 cm below. A clamping column is mounted in the lower magnetic foot, the bearing bolt with clamping insert is then fixed in this column.

A cord of about 120 cm is provided with loops at the ends, so that the total length is about 110 cm.



The cord is looped into the bearing pin of the upper magnetic base. Then wound once over the axis of the bearing pin on the lower magnetic base.

The pendulum ball wood is hooked into the loop of the cord. By moving the lower magnetic foot, the pendulum length is adjusted to 50 cm:

The pendulum length is the distance from the bearing bolt to the center of gravity of the suspended mass. Since the ball has a diameter of 60 mm, a distance of 47 cm is set from the top of the ball to the bearing bolt.

The 100 cm scale is placed horizontally on the table behind the sphere. This is moved so that the center of the ball hangs in the fall line in front of a dm - mark.



# THREAD PENDULUM - LARGE PENDULUM BALLS

SWD 01.01a

## Experiment 1:

It is to be examined whether the deflection (amplitude) has an effect on the oscillation period of a pendulum.

The pendulum length  $l$  is set to 50 cm.  
The pendulum is deflected about 5 cm from the rest position and released.

The time duration for 10 oscillations (1 oscillation consists of a back and forth movement) is measured. Two measurements are to be made for each deflection quantity. The duration  $T$  for 1 oscillation is calculated from the mean value. The results are entered in the table below.

Deflection $n$ (in cm)	Period of oscillation 10 $T$ (in seconds)		Period of oscillation $T$ (in seconds)
	Measurement 1	Measurement 2	
5			
10			
15			
40			



The deflection is changed as indicated in the table, the times are measured and entered in the table.

## Result:

The period of oscillation is about the same for the first three tests, the value of the fourth measurement is noticeably larger.

The deflection of the pendulum bob, if it is small, has no effect on the period of oscillation.

## Note:

The maximum deflection is also called amplitude.

# THREAD PENDULUM - LARGE PENDULUM BALLS

SWD 01.01a

## Experiment 2:

To investigate whether the mass of the pendulum bob has an effect on the period of oscillation of a pendulum

For this purpose, the masses of the two pendulum spheres are determined with an accurate balance:

Pendulum ball wood: ..... g

Pendulum ball plastic: ..... g

The pendulum ball plastic is hooked into the loop of the cord.  
The pendulum length  $l$  is set to 50 cm.  
The pendulum is deflected about 10 cm from the rest position and released.

The time period for 10 oscillations (1 oscillation consists of a back and forth movement) is measured. Two measurements are to be made. The duration  $T$  for 1 oscillation is calculated from the mean value. The results are entered in the table below.

Pendulum ball	Schwingungsdauer 10 T (in Sekunden)		Period of oscillation T (in seconds)
	Measurement 1	Measurement 2	
Plastic			
Wood			



The results with the wooden ball can be taken over from experiment 1.

## Result:

The period of oscillation of the two spheres is approximately the same.  
The mass of the pendulum bob therefore has no effect on the period of oscillation.

# THREAD PENDULUM - LARGE PENDULUM BALLS

SWD 01.01a

## Experiment 3:

It is to be examined whether the pendulum length has an effect on the oscillation period of a pendulum.

The pendulum ball plastic is hooked into the loop of the cord.  
The pendulum length  $l$  is set to 25 cm.  
The pendulum is deflected about 10 cm from the rest position and released.

The time period for 10 oscillations (1 oscillation consists of a back and forth movement) is measured. Two measurements are to be made for each pendulum length  $l$ . The duration  $T$  for 1 oscillation is calculated from the mean value. The results are entered in the table below.

Pendulum length $l$ (in m)	Period of oscillation 10 T (in seconds)		Period of oscillation T (in seconds)
	Measurement 1	Measurement 2	
0,25			
0,50			
0,75			
1,00			



The results of the pendulum length 50 cm can be taken over from experiment 2.

## Result:

With greater pendulum length, the period of oscillation also becomes greater.  
At four times the pendulum length, the period of oscillation is about twice as long.  
The pendulum length does indeed have an effect on the period of oscillation.

## Conclusion:

The period of oscillation of a string pendulum is independent of the deflection and the weight of the pendulum bob. If the length of the pendulum is doubled, the period of oscillation is twice as long.

We compare the experimental results with the formula

$$T = 2\pi \sqrt{\frac{l}{g}}$$

# THREAD PENDULUM - LARGE PENDULUM BALLS

SWD 01.01a

## Experiment 4:

The formula for the period of oscillation of a string pendulum allows a very simple and accurate measurement of the acceleration due to gravity.

The pendulum ball plastic is hooked into the loop of the cord.

The pendulum length  $l$  is set to about 75 cm. The pendulum length is now measured to the nearest mm and converted into m and entered in the table below.

The pendulum is deflected about 10 cm from its rest position and released.

The time period for 10 oscillations (1 oscillation consists of a back and forth movement) is measured. Two measurements are to be made. The duration  $T$  for 1 oscillation is calculated from the mean value. The results are entered in the table below.

Pendulum length $l$ (in m)	Period of oscillation 10 $T$ (in seconds)		Period of oscillation $T$ (in seconds)
	Measurement 1	Measurement 2	

From the formula for the period of oscillation  $T = 2\pi \sqrt{\frac{l}{g}}$

you get the acceleration due to gravity  $g$  with  $g = \frac{4\pi^2 l}{T^2}$

### Result:

$g = \dots\dots\dots$  m/s<sup>2</sup>

### Conclusion:

Using a string pendulum with a known pendulum length, the acceleration due to gravity  $g$  can be calculated.

### Note:

The value of the acceleration due to gravity is 9.81 m/s<sup>2</sup>. The exact value depends on the distance to the center of the earth (9.83 at the poles and 9.78 at the equator)

Accurate measurement of the pendulum length is essential for the result in this experiment.

You are welcome to calculate the acceleration due to gravity for the pendulum lengths, which are obtained by adding and subtracting 5 mm to the measured pendulum length.

# THREAD PENDULUM - LARGE PENDULUM BALLS

SWD 01.01a

For this experiment, it is recommended to use distance sensor and measurement software.



Due to the 20 times per second distance measurement, the periodic process of the pendulum swing can be reproduced optically very nicely.

With most software programs, you can determine the time duration of each oscillation quite precisely.

If the software allows to superimpose the sinusoidal oscillations of different measurements, the comparison of the oscillation processes is optically self-explanatory.