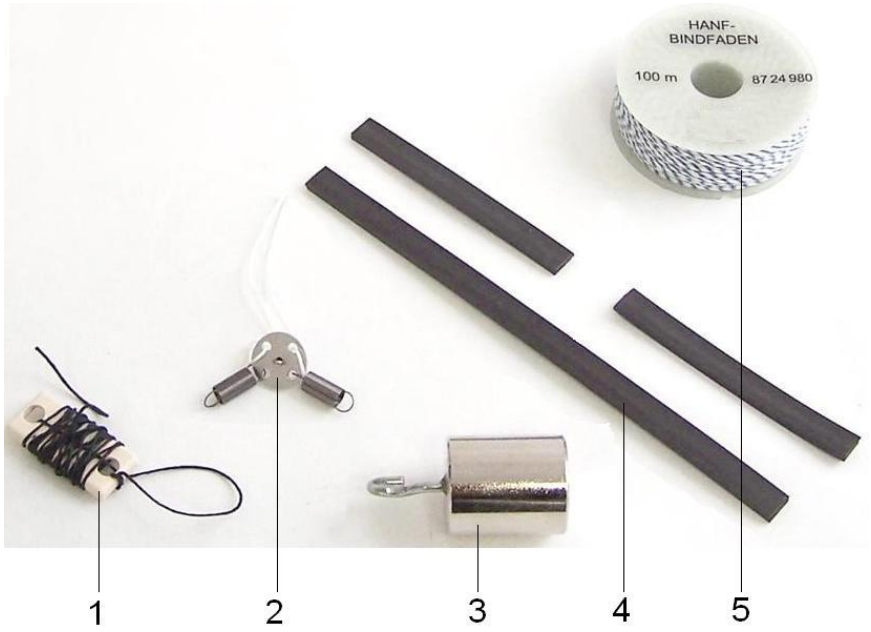
Supplementary Kit “String Pendulum” 1012854

Instruction manual

10/16 TL/ALF



1 String with length adjustment slider
2 Spring module with vector plate
3 Weight
4 Set of magnetic strips
5 Roll of string

1. Description

The Supplementary Kit “String Pendulum” has everything you need to build a string pendulum and carry out extensive experiments on harmonic and chaotic oscillations using a space-saving table-top set-up.

It features a roll of string, a weight, a movable plastic slider for changing the length of the pendulum and magnetic strips for the purpose of creating chaotic oscillations. A spring module makes it possible to connect the pendulum to the dynamic force sensors from the set Sensors “Mechanical Oscillations” in order to record and analyse oscillations with two degrees of freedom by means of an oscilloscope.

2. Equipment

1 String, 100 m
1 Weight 100 g
1 Long magnetic strip
2 Short magnetic strips
1 Spring module

3. Technical data

Spring constant of individual springs:	80 N/m approx.
Maximum force permitted on pendulum string:	10 N
Maximum recommended deflection of pendulum:	25°

4. Functioning principle

In a stationary position, the only forces acting on the hook of the dynamometer are those of the opposing tension springs (cf. Fig. 2). All motion of the string pendulum about the effectively stable eyelet hole from which it is suspended is resolved into two vectors and detected by the dynamic force sensors. For small angles, the output voltage from the amplifier board is almost proportional to the deflection of the pendulum (cf. Fig. 5).

A circular motion of the pendulum creates sinusoidal AC voltages at both amplifier outputs, which are out of phase with one another by 90°or -90° depending on the direction of rotation.

5. Operation

5.1 General information

The following additional equipment is necessary in order to carry out the experiments:

1 Stand Equipment “Mechanical Oscillations” 1012849

1 Sensors “Mechanical Oscillations”
@230V 1012850
or
@115V 1012851

1 USB oscilloscope 2x 50 MHz 1017264
1 PC, operating system Win XP, Vista, Win 7

or

1 Analogue oscilloscope 2x 30 MHz 1002727

Caution: Dynamic force sensors must not be subjected to mechanical overloading

- Neither sensor hook may be loaded with more than 5N in the axial direction and 1 N in transverse direction.
- Be especially careful with the maximum loading force when assembling the system or suspending loops or springs from the hook.
- Make sure stand rods are firmly fitted into the base and that all other mounting elements are also firmly fitted to the stands.

5.2 Set-up for string pendulum

- Screw the stand rods with both external and internal threads into the outer threaded sockets of the base plate.
- Extend both rods by screwing rods with external thread only onto the ends of them.
- Attach double clamps near the top of both stand rods and turn them to point inwards so that the slots are vertical and facing one another.
- Attach both springs from the spring module to the lugs on the cross bar (angled side).
- Hang the large loop of string from the lug on the flat side.

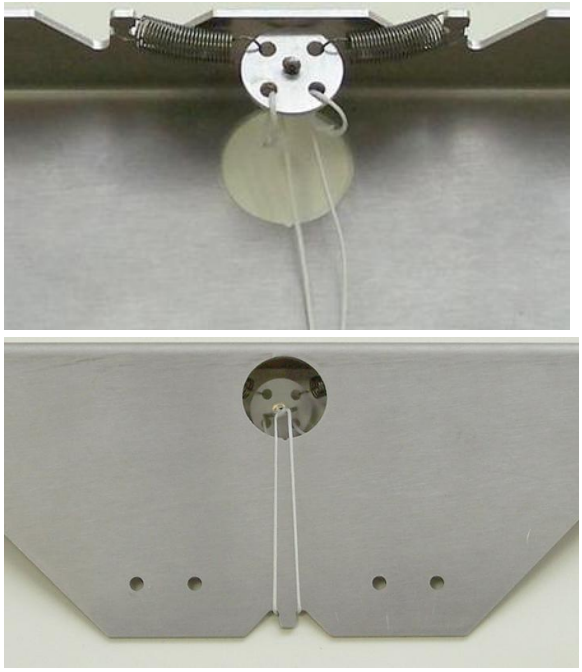


Fig. 1 Assembly of spring module

- Connect the springs and vector plate to the hook of a dynamic force sensor with a small loop of string and carefully pull everything taut.
- Attach the force sensor with the screw tightened by hand.
- Attach the second force sensor in the same way.

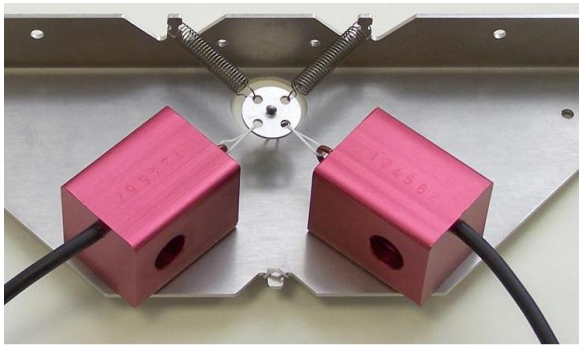


Fig. 2 Attachment of dynamic force sensors to spring module

- Pull the string through the eyelet of the spring module (in the middle of the metal disc).
- Thread the end of the string through the two holes of the length adjustment slider.

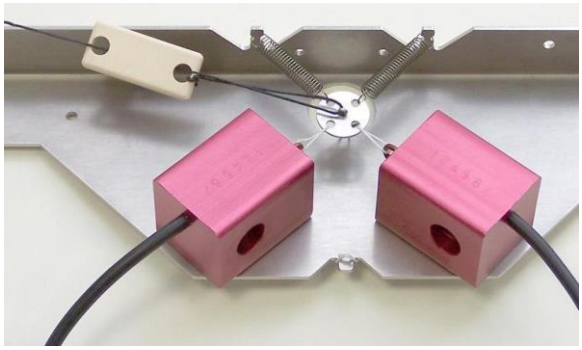


Fig. 3 Set up of string

- Clamp the cross bar into the slots of the two double clamps, suspend a weight from the end of the string and set up the height of the pendulum using the length adjustment slider.

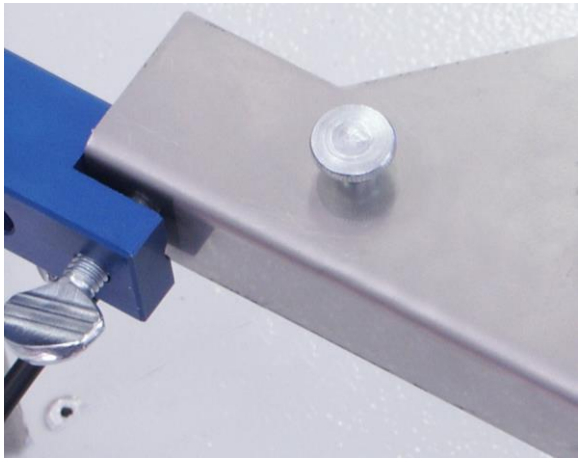


Fig. 4 Attachment of cross bar in double clamp

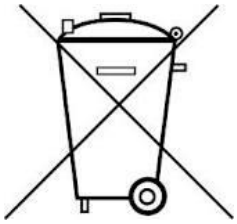
- Connect the force sensors to the inputs for channels A and B of the MEC amplifier board.
- Connect the outputs to an oscilloscope and start the experiment.

5.3. Set up for chaotic pendulum

- Set up the pendulum as previously described.
- In order to make the pendulum chaotic, place magnetic strips on the base plate under the pendulum bob.

6. Disposal

- Packaging and components should be disposed of, where necessary, at local recycling centres.



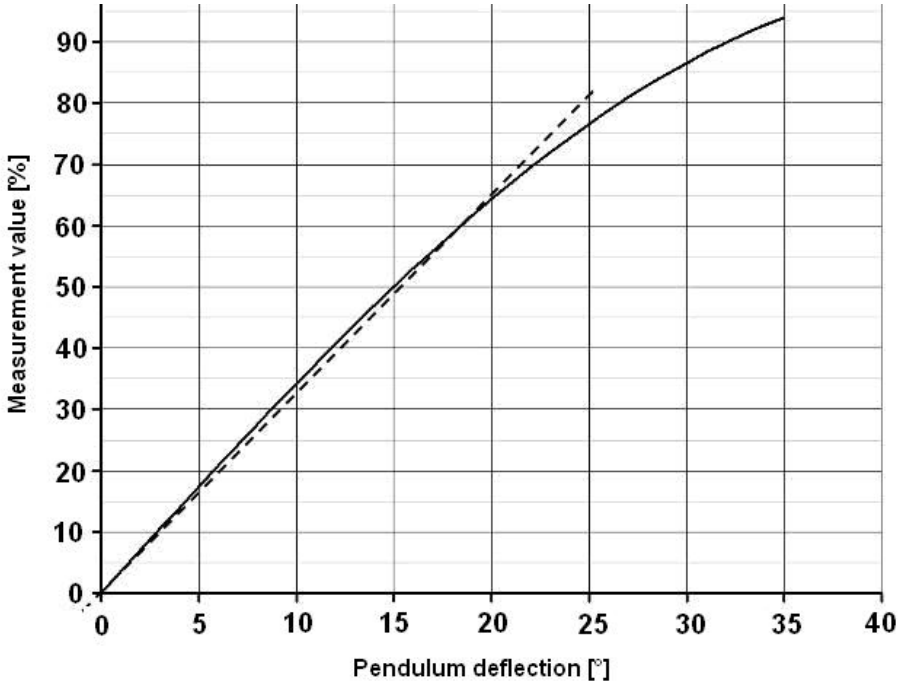


Fig. 5 Measured voltage as a function of pendulum deflection

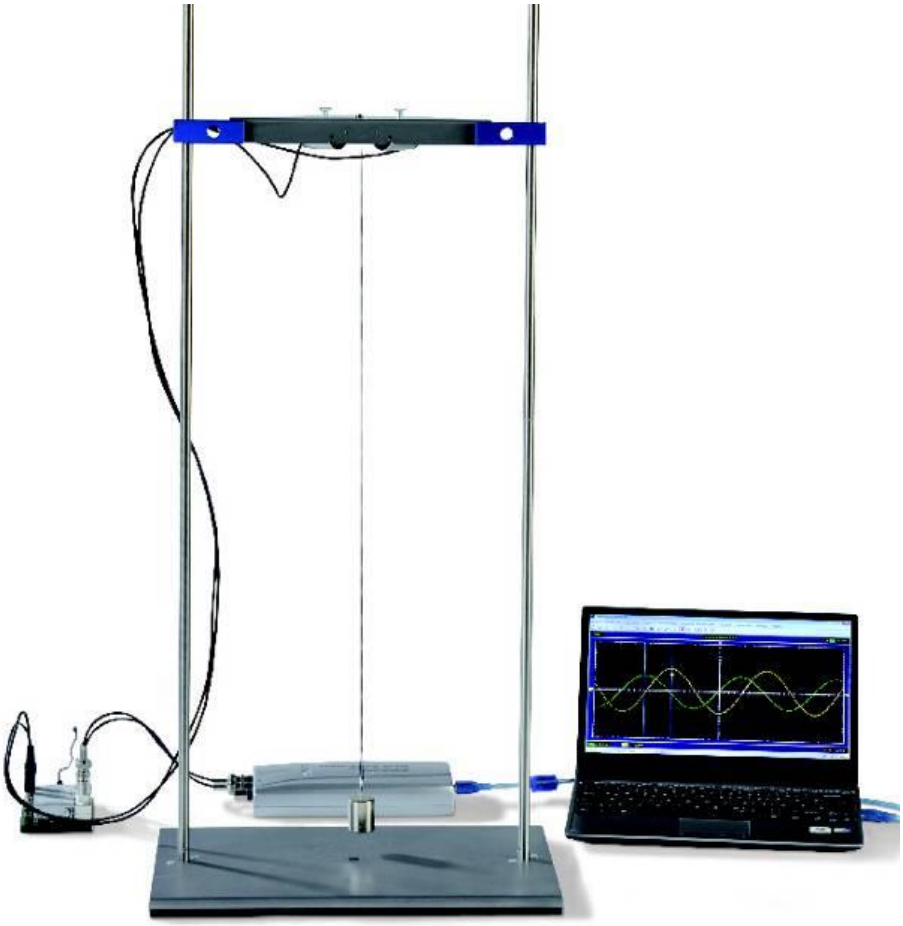


Fig. 6 String pendulum with USB oscilloscope