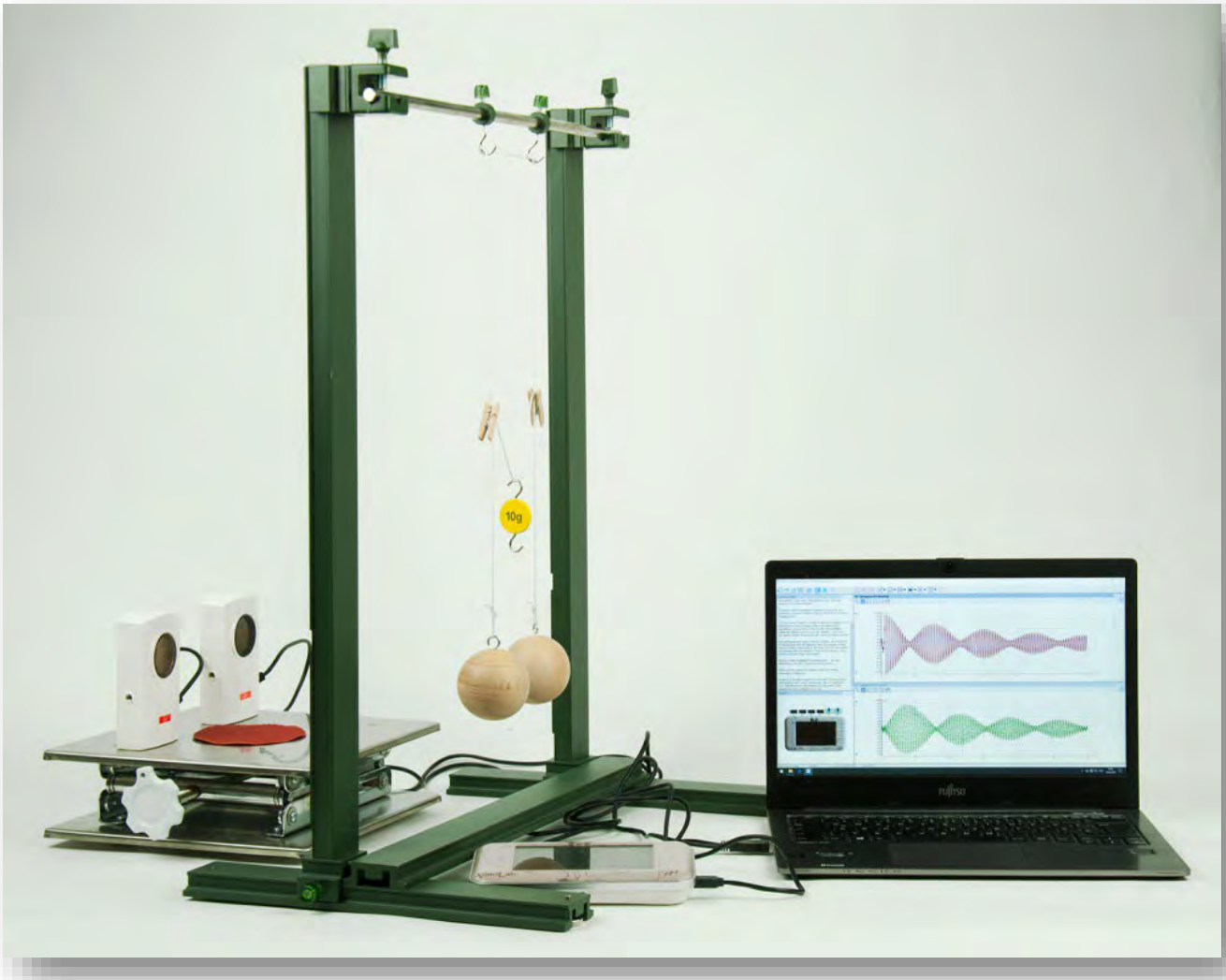
COUPLED PENDULUM

SWD 01.13



Material:

Item Code	Qty	Description
DS101-1G	1	Support base, large, L=500 mm
DS600-6G	1	Board holders, pair, magnetic
DS141-1R	2	Sliding saddle with bosshead
DS202-1R	2	Ring with hook
P7240-1G	1	Support rod, round, L=500 mm, D=10 mm
DG200-1S	1	Cord, white, D=1.7 mm, L=5 m
DM360-5H	1	Ball, D=60 mm, wood
DM121-2A	1	Weight on hook 10 g, profi
DS500-5K	2	Clamp wooden, small, L=35 mm
P4910-2U	1	VinciLab datalogger, USB, serial, incl. Coach Lite
P4210-5B	2	Sensor motion US, 0.2 ... 6 m (digital)
C7235-2D	1	Lab-jack, 200x200 mm

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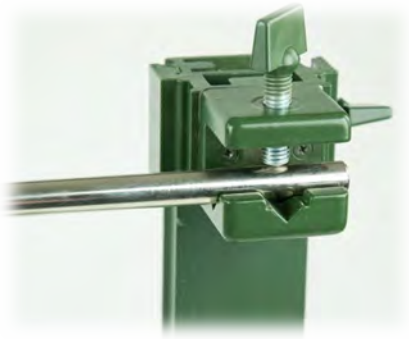
Goal:

Observation of the processes in coupled pendulums - coupling as the basis of the propagation of oscillations.

Setup:

The large support base is set up on a stable base.
The board holders are attached to the stand base behind the center rail on the foot cheeks.

A sliding saddle with bosshead is screwed to the upper ends of each board holders.



Two rings with hooks are pushed onto the 500 mm support rod.
The support rod is inserted into the sleeves of the sliding saddles and fixed in place.

The two rings with hooks are fixed centrally on the support rod at a distance of about 15 cm. The hooks should point downwards.

From the cord cut a piece of about 110 cm and put a loop at both ends. The remaining length of the cord with the loops should then be about 100 cm.
This cord is hooked into both hooks of the rings with hooks.
The two pendulum balls wood are hooked into the loops of the cord. The cord is moved in the hooks so that both pendulum balls hang at the same height, so the pendulum length of both pendulums is the same.

Another piece of cord about 20 cm is cut and clamped to the pendulum cords at about mid-height with the small wooden clamps.
The hook weight 10 g is hooked into this cord.

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Structure when using a data acquisition system:

The Lab-jack large is set up next to the stand base.
Two motion sensors are placed on the Lab-jack so that the direction of the ultrasonic sensor points exactly to the pendulum spheres.
The distance sensor - pendulum ball must be at least 40 cm.

The motion sensors are connected to the interface and the interface is connected to a PC.

The measured value of the two motion sensors is to be displayed on the same screen in two diagrams (distance/time) lying one below the other.
The measurement duration is set to two minutes.
At least 20 measurements/second should be taken to make a good recording.

Experiment:

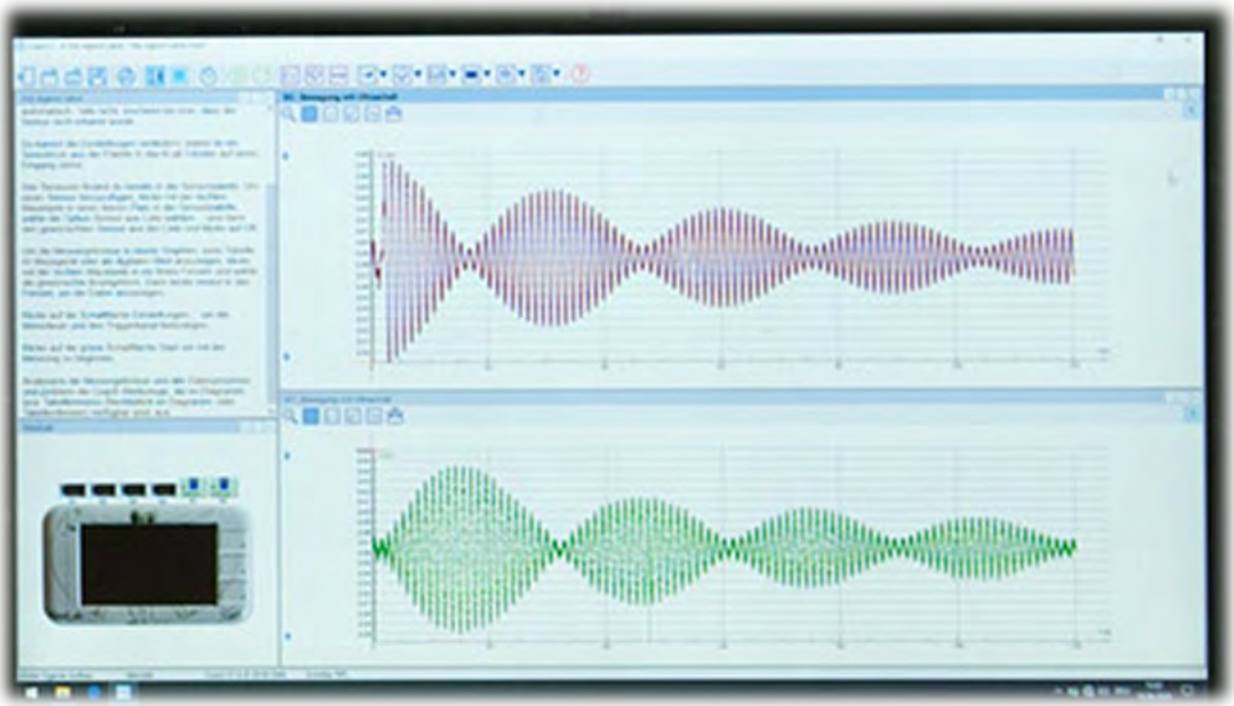
The measurement is started.

One of the two pendulum balls is deflected about 10 - 15 cm and released. Of course, the deflection of the pendulum ball should not occur between the sensor and the ball.

The record in the diagrams is observed.

Result:

By deflecting and releasing one of the two pendulums, it begins to swing. This oscillation energy is transferred to the second pendulum by the coupling (string with hook weight).
If one of the pendulums has a maximum, the second (coupled) pendulum has a minimum of oscillation energy.
From the diagrams it is easy to see that this energy is periodically transferred back and forth between the two pendulums.



Note:

Another way of looking at it: Each of the two pendulums performs beatings, the frequency of which depends on the strength of the coupling. Beats occur when two oscillations with slightly different frequencies are superimposed. These two oscillations are the natural frequency when the pendulums are allowed to oscillate in phase and the slightly larger frequency due to the pull of the coupling weight when they are allowed to oscillate against each other (in antiphase). With stronger coupling, the frequency difference and thus also the beat frequency is greater.
Coupling phenomena occur wherever two vibrating systems can influence each other in some way and therefore play a major role. Example: longitudinal and torsional oscillation of a spring

If the pendulums are of different lengths, then the phase difference changes during transmission and the energy is no longer passed on completely.