Forced oscillation and resonance (Item No.: P1003100)

Curricular Relevance

Area of Expertise: Physik
Education Level: Klasse 10-13
Topic: Mechanik
Subtopic: Schwingungen und Wellen
Experiment: Erzwungene Schwingungen und Resonanz

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	10 Minutes	2 Students

Additional Requirements:

Experiment Variations:

Keywords:

Task and equipment

Information for teachers

Additional Information

In the Experiment "Helical spring pendulum" the students have determined the natural frequency of a spring pendulum and established this frequency dependence on pendulum mass and spring constant. In this experiment they should force a spring pendulum to oscillate and from observations of the forced oscillation amplitude make conclusions concerning the correlation between excitation frequency and natural frequency.
Furthermore, the natural frequency of a spring pendulum should be measured and then compared with the (approximate) natural frequency determined in the second part of the experiment.

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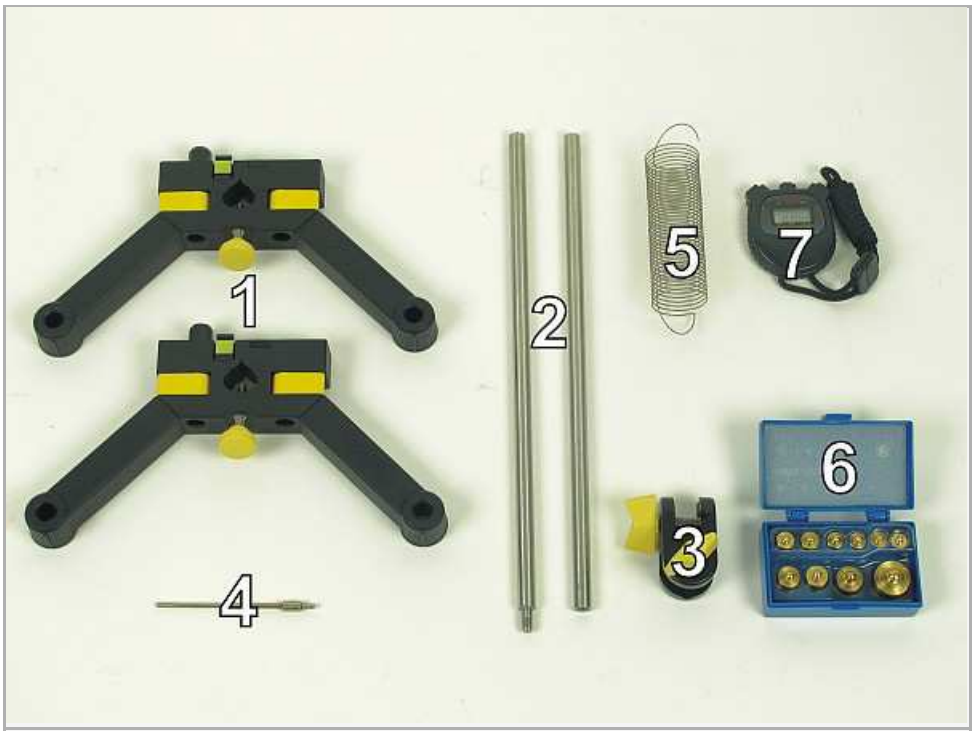
Task and equipment

Task

How can the oscillations of a spring pendulum be induced?

Start a spring pendulum oscillating with your hand and observe the effect.
Measure the oscillation frequency with which the spring pendulum oscillates normally.

Equipment



Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	1
3	Boss head	02043-00	1
4	Holding pin	03949-00	1
5	Helical spring, 3 N/m	02220-00	1
6	Set of precision weights,1g-50g	44017-00	1
7	Stop watch 4	03078-00	1
Additional material			
	Scissors		

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Set-up and procedure

Set-up

First screw the splitt support rod together (Fig. 1). Set up a stand with the support base (Fig. 2), put the support rod in the support base and tight it with the screw (Fig. 3).

Fig. 1

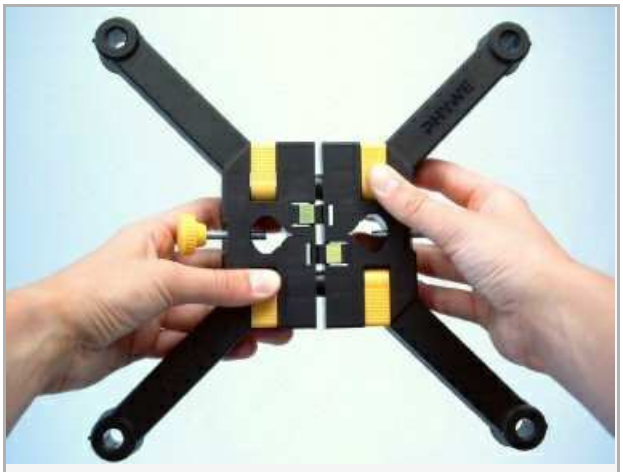

Fig. 2

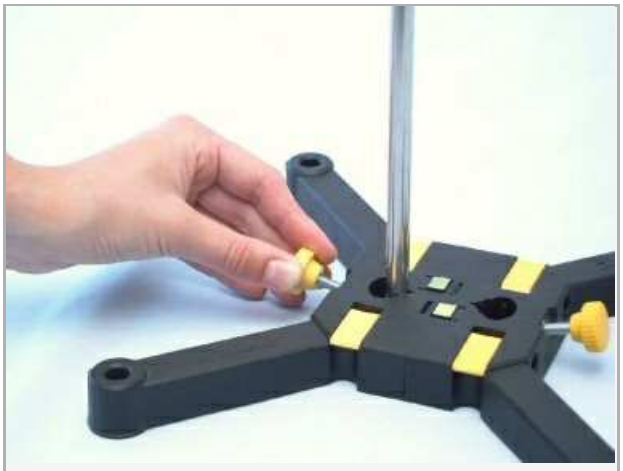

Fig. 3

Fix the bosshead to the support rod. Fix the holding pin in the bosshead and hang the helical spring in it (Fig. 4). Attach a 50 g mass piece from the weight set to the helical spring (Fig. 5).

Fig. 4

Fig. 5

Procedure

- Deflect the spring pendulum downwards and let it oscillate at its natural oscillation frequency (Fig. 6).
- Start the stop watch when the pendulum is at its lower reversal point and measure the time required for 10 complete oscillations.
- Repeat this measurement twice and record the times in Table 1 in the report.

Fig. 6

- Take hold of the upper end of the helical spring (Fig. 7).
- Move your hand up and down with the spring pendulum very slowly (low excitation frequency). Observe the movement of the spring pendulum and record your observations in the report.
- Move your hand more rapidly than before (intermediate excitation frequency) and again observe the spring pendulum.
- Move your hand more rapidly (high excitation frequency, i.e. larger than the natural oscillation frequency) and again observe the spring pendulum.

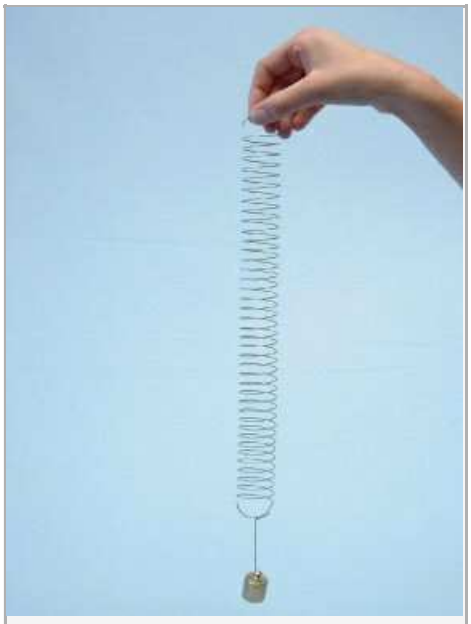

Fig. 7

In order to disassemble the support base you should press the yellow buttons (Fig. 8).

Fig. 8

Report: Forced oscillation and resonance

Results – Table 1

Record all the measured values in Table 1.

Calculate the average value for 10 oscillations and from it the time for one oscillation, i.e. the oscillation period T.

Use the oscillation period to calculate the pendulum's natural oscillation frequency of $f_o = 1/T$.

Measurement N	t_{10} in s	Average t_{10} in s	T in s	f_0 in Hz
1	1	1	1	1
2	1	1 ±0	1 ±0	1 ±0
3	1	1 ±0	1 ±0	1 ±0

Results – Observations 1

Write down your observations at low excitation frequency.

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Results – Observations 2

Write down your observations at intermediate excitation frequency:

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Results – Observations 3

Write down your observations at high excitation frequency:

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Evaluation – Question 1

How is the amplitude affected by

a) low excitation frequency?

b) intermediate excitation frequency?

c) high excitation frequency?

Evaluation – Question 2

How can you explain the observed behavior?

Evaluation – Question 3

One uses the term "resonance" to describe the case in which the excitation frequency and the natural frequency of an object capable of oscillation agree. How is the resonance of a spring pendulum noticeable?

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Evaluation – Question 4

What determines the oscillation frequency of a spring pendulum?

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Evaluation – Question 5

Who is the "exciter" in this case?

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