5.5 Forced oscillation and resonance

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.

Use the space below for your own notes.

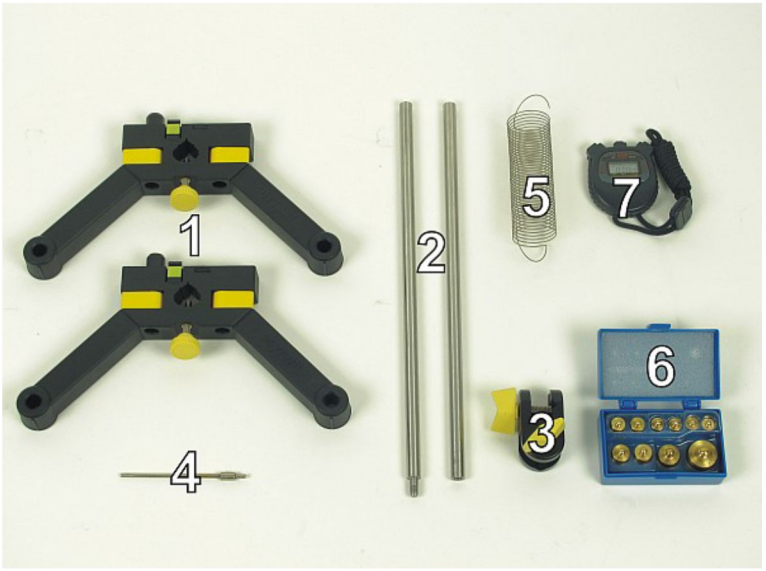
Material

Material from "TESS advanced Physics Set Mechanics 1, ME-1" (Order No. 15271-88)

Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, split in 2 rods, *l* = 600 mm	02035-00	1
3	Bosshead	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, in case	44017-00	1
7	Stop watch, digital, 24h, 1/100 s and 1 s	24025-00	1
8	Fish line, in reel, *d* = 0.7 mm, 20 m	02089-00	10 cm
Additional Material			
	Scissors		1

Material required for the experiment



Setup

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

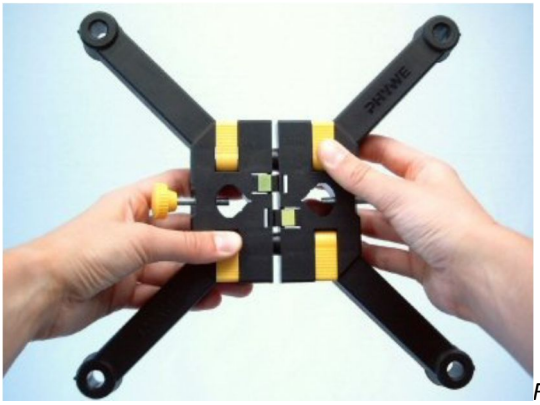


Fig. 2

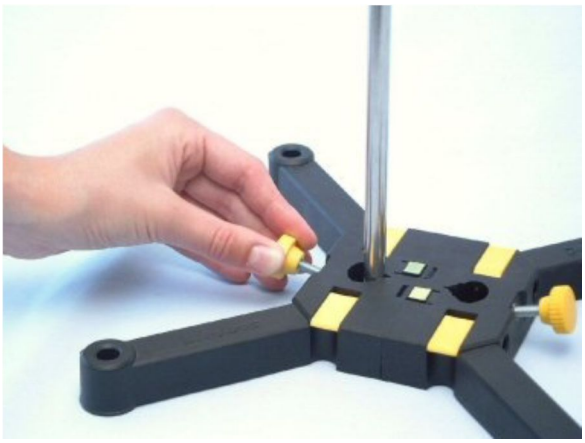


Fig. 3

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).

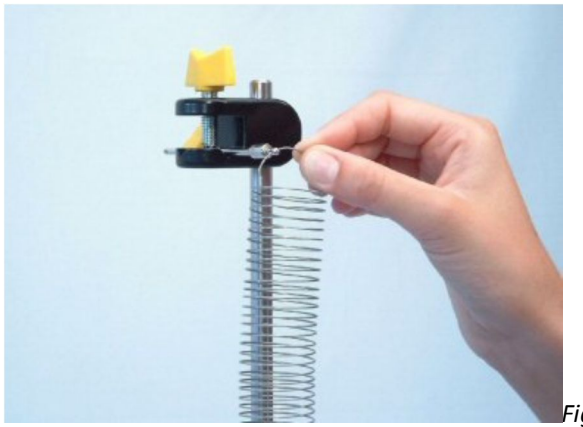


Fig. 4


Fig. 5

Action

- 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 on the Results page.


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 Results page.
- 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.

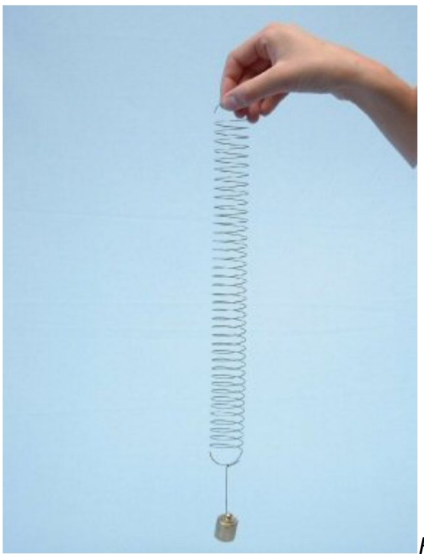


Fig. 7

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


Fig. 8

Results

Table 1

Measurement No.	t_{10} in s	Average t_{10} in s	T in s	f0 in Hz
1				
2				
3				

Result 1

Low excitation frequency (note your observations):

Result 2

Intermediate excitation frequency (note your observations):

Result 3

High excitation frequency (note your observations):

Evaluation

Question 1:

How is the amplitude affected by

• low excitation frequency?

• intermediate excitation frequency?

• high excitation frequency?

Question 2:
How can you explain the observed behavior?

Question 3:

From the values in Table 1 on the Results page calculate the average value for 10 oscillations and from it the time for one oscillation, i.e. the oscillation period *T*. Record the results in Table 1.

Question 4:
Use the oscillation period to calculate the pendulum's natural oscillation frequency of $f_0 = 1/T$ and record the result in Table 1.

Question 5:
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?

Question 6:
What determines the oscillation frequency of a spring pendulum?

Question 7:
Who is the "exciter" in this case?