NAEST-2021

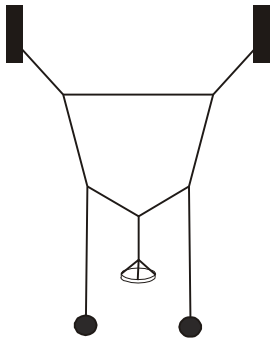
Prelim experiment 2: Study the oscillations of special pendulums

Part-A: Coupled Pendulum

If two simple pendulums are connected to each other by a string/wire, the oscillations of one pendulum will affect the other. Such an arrangement is called a coupled spendulum.

Making the coupled pendulum:

To make the coupled pendulum, you will require strings and two identical solid objects. Fasten astring to two vertical stands such that the string is horizontal. Now make two identical simple pendulums and tiethem to the string at a certain separation.
Tie another shortstring to the two individual pendulums and suspend a pan balance/weight from the middle of this tying string. The whole set up is schematically shown in the figure.



Make your own pan balance
You may use small plastic plates/cups and tie them with strings to create the balance. Think of ways to make homemade weights which can be varied in equal steps.

Measure time period T_1:

Keeping the initial phase difference between the pendulums to be zero, oscillate them and find the time period of these oscillations.

Measure time period T_2:

Keeping the initial phase difference between the pendulums to be π, oscillate the pendulums and findthe time period of these oscillations.

Measure time period T_3:

Keeping the first pendulum stationary,displace the second pendulum through a distance and release. You will notice that its oscillations die down after some time and the first pendulum picks up oscillations gradually. After some time the oscillations of the first pendulum die down and the second pendulum gradually starts oscillating,and then it stops again. This process continues for some time. The time between the consecutive stops of second(or first) pendulum is T_3.

Find T_1, T_2 and $T_3$for variousweights in the range of about 0 – 100g.
Tabulate and analyze the data obtained. Plot the variation of T_1, T_2 and T_3 with weights in the pan.

Do you see a relation between T_1, T_2 and T_3? State how you reached to this relation.

Oscillations can be done perpendicular to the plane of the pendulumor in the plane of the pendulums or both**.**Plane of the pendulum refers to the plane when the pendulums are at rest.

Part B: A pendulum with multiple frequencies

For doing this part of the experiment, you have to create a new setup which is described below

The experimental Setup:

Tie a string to two rigid supports A and B as shown in figure (a) below. A plastic bottle is to be suspended from the string connected to A and B. Make appropriate arrangements to tie the bottle to a string as shown in figure (b). Make sure the bottle is nearly vertical. Make a small hole at the bottom of the bottle. Nowfill the bottle with sand/salt or any other free flowing material. Check that the hole is of appropriate size so that the material filled in it can continuously come out. Close the hole using a cello-tape, fill it with your material and suspend it as shown in figure (c).The bottle may be at an appropriate height from a horizonal floor or platform where the sand can fall and make a pattern.

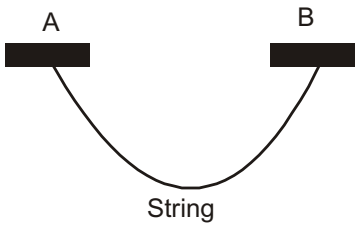


Figure (a)

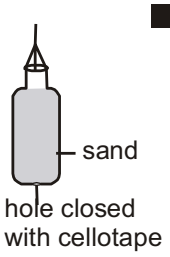


Figure (b)

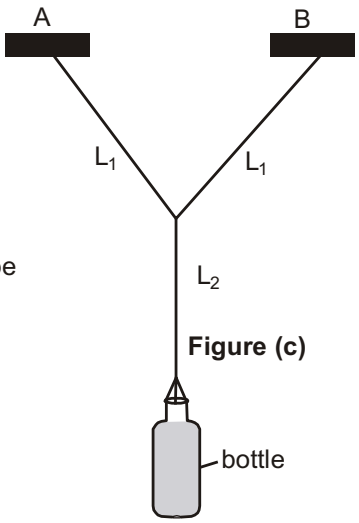


Figure (c)

Oscillations

Let the vertical plane through the strings be called plane M. Pull the bottle in this plane through a certain distance and release. Study the oscillations of the bottle.

Next, pull the bottle perpendicular to plane M through a certain distance and release. Study the oscillations.

Now pull the bottle at an angle of 45 degrees with plane M and release. Again study the oscillations.

Study the sand patterns

Pull the bottle at an angle of 30 degrees from the plane M. Remove the tape from the bottom of the bottle and release. Describe the pattern formed by the falling sand. Repeat

it by oscillating the bottle at angles of 45 and 60 degrees with the plane M. Record the patterns formed.

Expected photos and videos

i) Photo of the coupled pendulum
ii) Short video (about 1min) of the measurement of time period T_3
iii) Photo of theexperimental setup for part B
iv) Photo of a sand pattern
v) Short videos (of less than a min) of the pattern being formed for 30 and 45 degree angles

Suggested explorations:

Part A

- You may study the effect of
  a) separation between the individual pendulums
  b) tension in the upper string
  c) length of the pendulums

Part B

- Effect of variation of ratio $L_2/L_1$of thestrings.
- Measure the time period of oscillation for 0 and 90 degree in part B. How do they compare with each other?

Other investigations you can think of.