National Anveshika Experimental Skill Test -2021

(NAEST – 2021)

Name:.....Class.....

Roll NO.....Mobile No.....

School/College Name.....

Date.....Time.....

SF1- To study the wave propagation on a Tape - Spoke system

Background

When we make a small disturbance in a medium, the disturbance reaches other parts of the medium in due course of time. The coupling between different parts of the medium facilitates this propagation. The propagation of a disturbance in a medium due to bonding of its parts is called wave.

For a one-dimensional wave propagation in a homogenous medium like a rope or string, the wave speed is given by

$$v = \sqrt{T/m} \qquad (1)$$

where T is the tension in the string and m is the mass per unit length of the string.

We present you with a highly non-uniform medium on which a twist-wave will propagate in one direction and you are supposed to study the speed of the wave on it.

Apparatus/medium

A number of bicycle spokes are sandwiched between two layers of a cello-tape, sticking to each other (Figure 1). The whole system is hanged from a height. A pan is attached to the lower end. All the spokes have same length and weight and are placed perpendicular to the length of the tape at equal distances. Any spoke can be rotated slightly from its mean position and released. This creates a twist in the tape. This twist travels in the other parts of the tape like a wave.

The lowermost spoke will be called spoke-A and the uppermost spoke will be called spoke-C. The spoke at half-way is distinguished by tagging a colored string to it. This spoke will be called spoke-B.

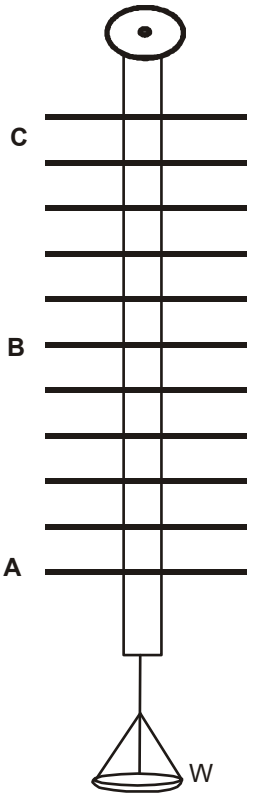

Figure - 1

You will be using the stop watch of your mobile phone in your experiment. If you are not familiar with it, please practice it. Especially practice the "lap" facility where you can record the time of an intermediate event while the stop-watch continues to run. If your mobile stop watch does not have the lap facility, consult the evaluator.

Materials

Weights of 50 g, a rotatable pvc pipe, one meter scale.

Experiment

Make the model stationary before doing any operation on it. Very gently hit the lowermost spoke to rotate it by a small angle. Observe how the wave propagates up along the model and then reflects from the top and comes back to the lowermost spoke.

Part-A: Measure the length of the straw-tape model.

A possible arrangement to measure the height of the model from the lowermost spoke to the point of suspension is shown in Figure-2. One way is to look through the pipe and adjust its orientation so that the top point is visible. Next do the same to see the bottommost spoke. Measure the angle between the two orientations. Measure the horizontal distance D and then get the height using the trigonometric equations.

Think of your own way to measure the height of the model as accurately as possible.

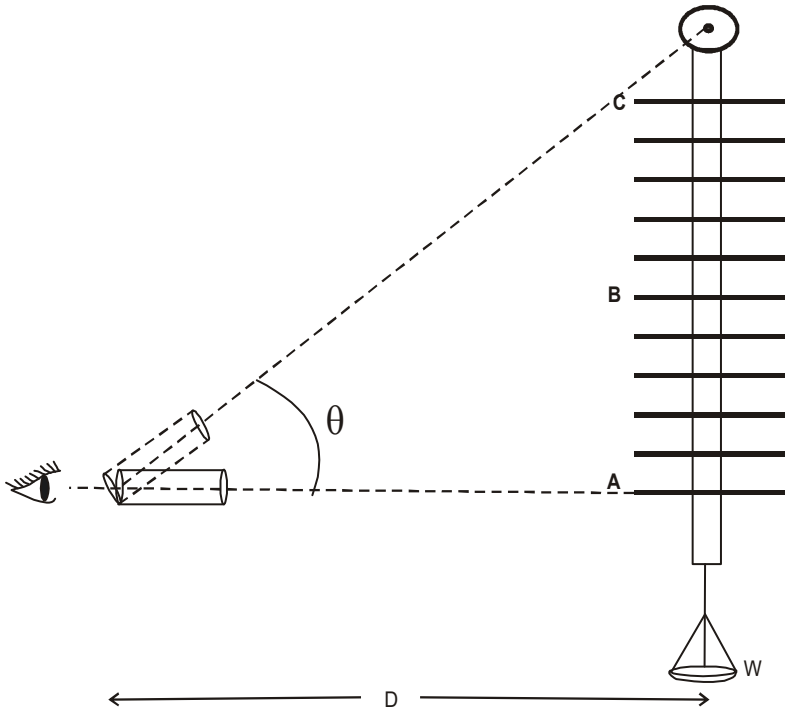

Figure - 2

Part-B: Measure the average wave speed

Be ready with your stop watch. Hit the spoke-A gently and at the same time start the stop watch. When the wave comes back to spoke A, stop the stop watch. From the height measured earlier and the time read on the stop watch calculate the average wave speed on the model.

Repeat with weights 100 g, 200 g, etc on the pan. Plot the average wave speed v vs W the weight on the pan. Also plot v^2 vs W. Suggest a functional form for the wave speed v as a function of W.

Part-C: Qualitatively study if the wave speed varies as the wave goes up on the model

In this you will be using the "Lap" feature of your stop watch. Gently hit the spoke-A and at the same time start the stop watch. As the wave reaches spoke-B, lap it. When the wave reaches spoke-B again (after reflection from the top end), lap it again. When the reflected wave reaches spoke-A, stop the stop - watch.

From these data find the average speed v of the wave in the lower half (A to B) and in the upper half (B to C). What do you conclude and how would you explain your findings?

Estimate of Errors/ Extensions/ Comments