(OS1-3) Meld's Experiment

Aim of experiment

Determination of mass per unit length of a fine wire using meld's experiment

Apparatus

Electrical Tuning Fork, a Thin Wire or Strings, Scale Ban and Loads

Theory of experiment

When a periodic force acts on a wire stretched between two fixed points, a transverse wave propagates along the wire with velocity:

$$v = \sqrt{\frac{T}{\mu}}$$

Where, T is the tension in the wire.

μ is the mass per unit length of the wire.

The generated wave will be reflected at both fixed points and the incident and reflected waves combine to produce a resultant motion. If the frequency of the fork is equal to one of the natural frequencies of the wire, a state of resonance takes place and the wire shows a stationary wave with a node at each fixed point and one or more antinodes between them.

The natural frequency of order n of the wire is given by:

$$f_n = \frac{v}{\lambda_n} = \frac{1}{\lambda_n}\sqrt{\frac{T}{\mu}} \qquad (1)$$

where n: is an integral (1,2,3,...).

For $n=1$, the stationary wave has only one loop (one antinode) and the frequency f_1 is called the first or fundamental harmonic frequency.

For $n=2,3,4...$ the stationary wave has 2, 3, 4,.... loops respectively and the corresponding frequencies f_2, f_3, f_4, …, are called the second, third, fourth …. harmonic frequencies.

Since the distance between two modes is equal to half wave length, so:

$$\lambda_n = 2L/n$$

Where L is the length of the wire between the two fixed points.

Squaring both sides one have:

$$f^2_n = \frac{1}{\lambda^2_n}\frac{T}{\mu} \qquad (2)$$

Or

$$\lambda^2_n = \frac{T}{f_n^{\,2}\mu} \qquad (3)$$

Procedures

1. Put a load (M) on the pan. The produced tension is: $T=(M + M')g$; where M' is the mass of the pan and g is acceleration due to gravity.
2. By properly adjusting the position of the vibrating fork, one can produce stationary or standing waves with well-defined nodes.
3. Measure the distance between two successive nodes; this will give $\lambda/2$ This can be done by counting the number of loops along the length (L) of the string, then the average value of (λ) is $\lambda = 2L/n$.
4. Increase the value of (M) and repeat steps 2 and 3 and find the corresponding value of λ.
5. Repeat steps 1-4 at least three times and find the average, λ_{av}.
6. Tabulate your results
7. Draw a relation between λ_{av}^2 and M; which gives a straight line whose slope is $g/(f^2\mu)$ from which deduce the value of (μ), the mass per unit length of the string.

Results

M(kg)	λ_1 (m)	λ_1 (m)	λ_1 (m)	λ_{av} (m)	λ_{av}^2 (m)

$f =$ 5o Hz

Slope = m/kg

$\mu =$ kg/m