(S1-4) Determination of the Mass Per Unit Length of a Fine Metal Wire Using a Sonometer

Aim of experiment

Determination of the mass per unit length of a fine metal wire using a sonometer

Apparatus

Sonometer – Iron Wire – Vibrating Solenoid Attached to a Function Generator– Micrometer, Meter Ruler.

Introduction

A sonometer consists of a firm frame carrying one fixed bridge over which a string or wire can be stretched. One end of the string is fixed over a fixed bridge, while the other end passing over a pulley carries a scale ban. The tension is adjusted by suspending masses in the scale ban hanging from it. There is usually considerable friction at the pulley, so that the tension on the string is not necessarily as the same weight hanging from the end. A movable bridge, *B* is also supplied; by moving this bridge along the string, the sounding length can be altered as well, and the bitch of the string changed as a result of the altered length.

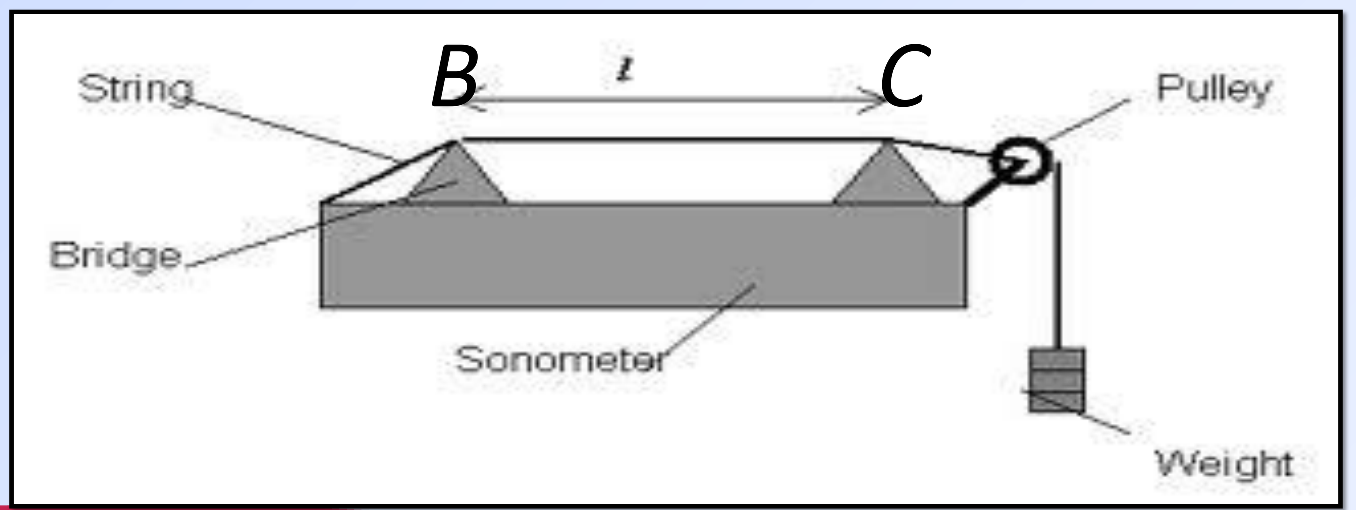

Figure 1. A schematic diagram of a Sonometer

Theory of experiment

If a string is stretched between two frames, *B* and *C*, *Figure 1,* and a disturbance, from a vibrating solenoid, is created at any point on the string, the disturbance travels to one end, and is there reflected to the other end. Here it is again reflected, but now in the same form as the original disturbance, so that the string is in exactly the same condition as first, after the disturbance has traveled twice along its length; the vibration of the string has completed one cycle, in case of fundamental tone.

Now, the velocity of propagation of transverse waves, v along a stretched string or a wire is given by;

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

Where T is the tension in the wire, and μ is the mass per unit length of the wire.

This equation yields;

$$v = f\lambda = \sqrt{T/\mu}$$

$$\lambda = \frac{1}{f}\sqrt{T/\mu}$$

$$\lambda^2 = \frac{1}{f^2\mu}T = \frac{g}{f^2\mu}M$$

Where $T=Mg$, M is the loaded mass; g is the constant acceleration of gravity. The relation between λ^2 and M is a straight line and μ is calculated from its slope

Procedure

1. Set the vibrating solenoid on top of the middle of sonometer wire and turn on the function generator and set it to a preset frequency , *f.*
2. Stretch the wire with a known force, *M.*
3. Move bridge *C* until you get nodes at both ends *, B and C*, and measure the distance between two nodes. This distance is half of the wavelength, λ/2.
4. Repeat the above steps at different loads and measure the corresponding resonance wavelength in each case.
5. Draw the relation between M and λ^2 and find the slope, from which deduce μ.

Results

f = ……. Hz

M (Kg)	λ_1 (m)	λ_2 (m)	λ_3 (m)	λ_{av}^2 (m^2)

Slope = …………

μ = Kg/ m