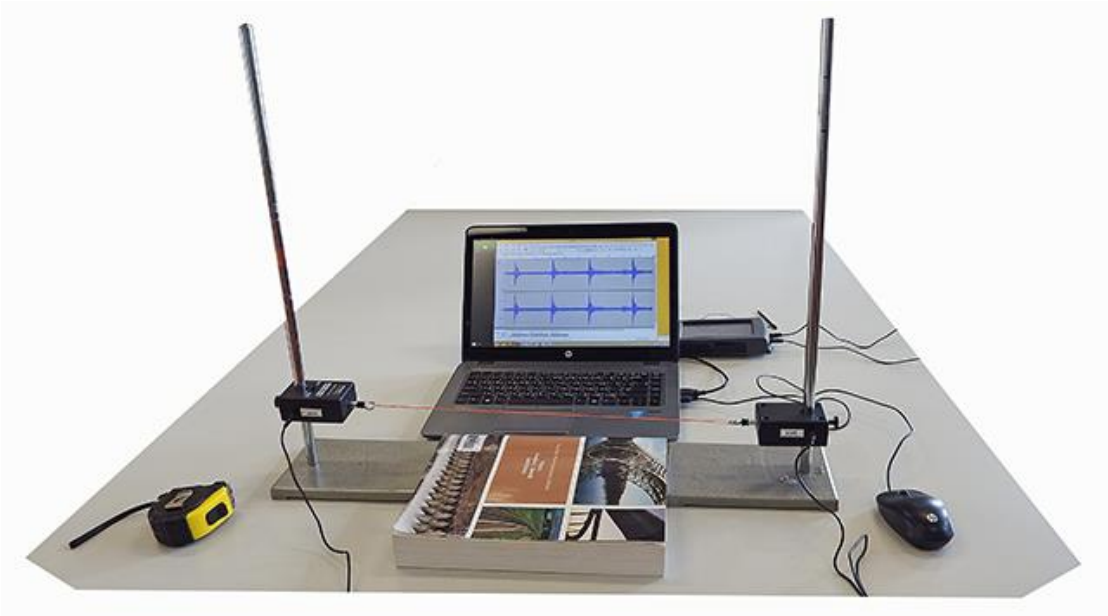
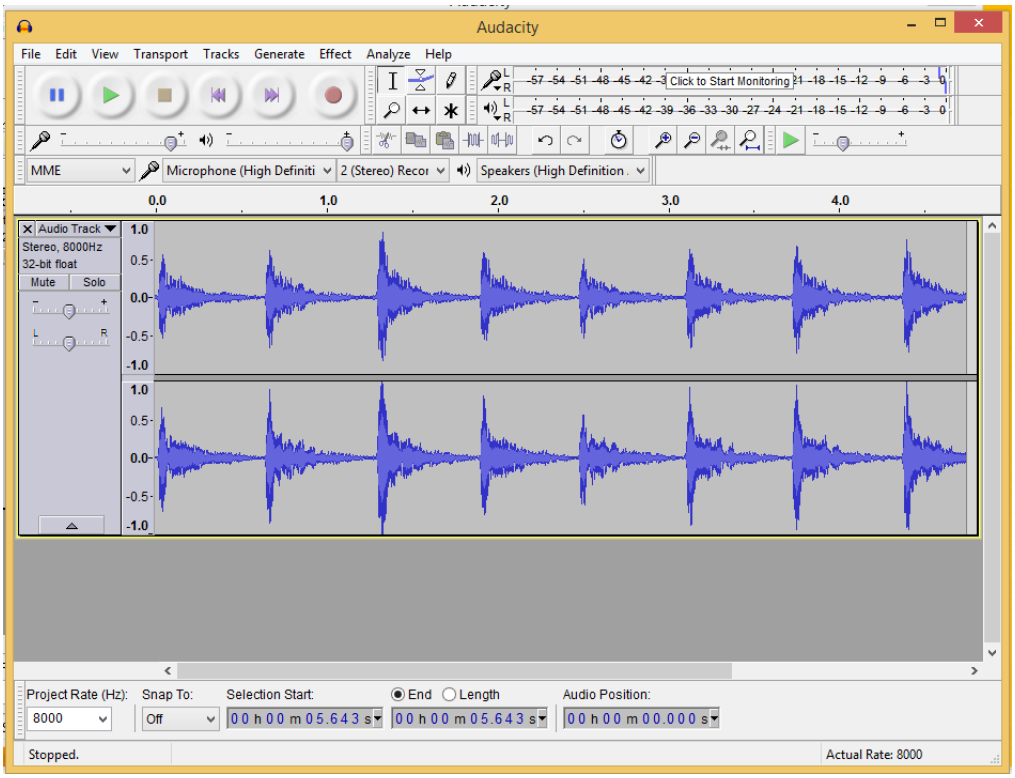
The mass of a rubber band

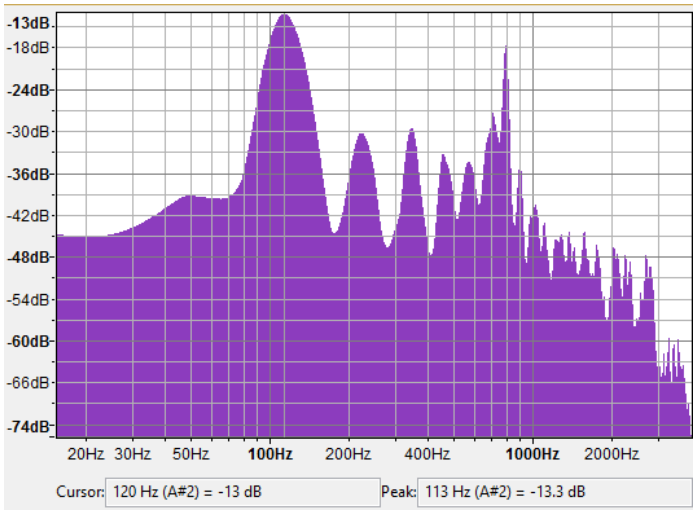
The stretched rubber band shown below is twisted like a two strand rope to form a single strand that vibrates at a little over 100 Hz when plucked. The clamp stands are held apart by a well-known teaching aid.



The rubber is repeatedly plucked and the sound is recorded in Audacity.



The frequency spectrum (*with project data set to 8000 Hz*) is shown below.



The frequency of the lowest (dominant) mode with one half wavelength on the rubber band is given in audacity as 113 Hz. The tension T in the rubber is given by the force probe reading as 5.48 N. The measured length L to the nearest mm is 41.8 cm.

The velocity of waves on a tensioned string is given for small amplitudes by …

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

… where the symbols have their usual meanings.

The reader may show using $v = f\lambda$ that the mass of the rubber band is given by …

$$m = T/4f^2L$$

Calculation gives the mass of the rubber band as 0.26 g in agreement to two significant figures with the value on the electronic balance below.

Note: ***check the zero setting and calibration of the force probe***. *Do not exceed a tension of about 8 N for the rubber bands used to tie up plastic food bags. Higher values of tension may introduce a difference of up to 10% due to the non-linear properties of rubber under high tension. A shorter rubber band will vibrate with a higher frequency improving the accuracy of that measurement.*