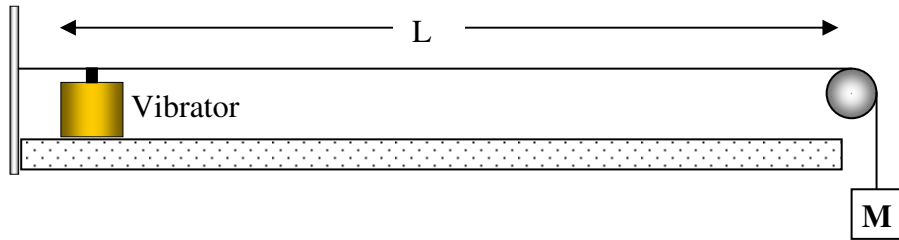


**Mini-Lab: Waves on a string**

1. There is a vibrating string apparatus on your table as shown in the diagram:



A frequency generator fed through an amplifier drives the vibrator with a frequency that you can read off the frequency generator dial.

- Rules:**
- Do not allow amplitude of oscillation of slotted rod to exceed 0.5 cm.
  - The sound of the vibrator should be barely audible.
  - Do not put your ears, or anybody else's ears, up against the apparatus.

2. Hang the mass  $M$  on the string. The wave speed = wavelength \* frequency =  $\sqrt{\frac{F_T}{\mu}}$  where  $F_T$  is the tension in string, and  $\mu$  is the mass per unit length of the string.

(a) Find any frequency at which it resonates: i.e., where the amplitude is a maximum and an integral number of half-wavelengths fit on the string. Record the frequency from the dial (with an estimated uncertainty) and sketch the pattern of the string. Note that the node may not be exactly at the end due to the action of the driving mechanism.

(b) Methodically estimate other frequencies at which this system should resonate. Verify this by checking out the patterns experimentally. For example, once you've found one resonance pattern, it's just a matter of a simple fraction ratio to estimate where the next one should be. Sketch the shape of the string and label it with the measured frequency on an **attached table** that starts from the **lowest** frequency you could find up to at least the first 8 patterns. (The all-time record is 31 nodes, but you needn't go anywhere near that high).

(c) It looks like we'll need the density of the string in order to be able to predict the resonant frequencies of this mass-string from scratch. Make the appropriate measurements and record them here. The catch: **Do not cut the string**. Non-destructive testing only. A sample piece of string is at the center table if you need to weigh one.

(d) When you calculate the predicted resonant frequencies above, how will you account for the fact that the string stretches?

(e) Calculate the theoretical resonant frequencies for the patterns in your table using the tension formula from the equation on page 1 and see how well they match with the measured experimental frequencies.

(f) Calculate the uncertainties in your theoretical calculations in (e), and show the details of how you estimated them. Do the theoretical and experimental frequencies agree within uncertainty?

(g) We won't do an abstract this time, but your final attached results table should have at least three numerical columns; the  $n$  value of the wave, the experimental frequency off the oscillator dial  $\pm$  uncertainty, and the theoretical frequency  $\pm$  uncertainty, all filled in for at least the first 8 patterns found.