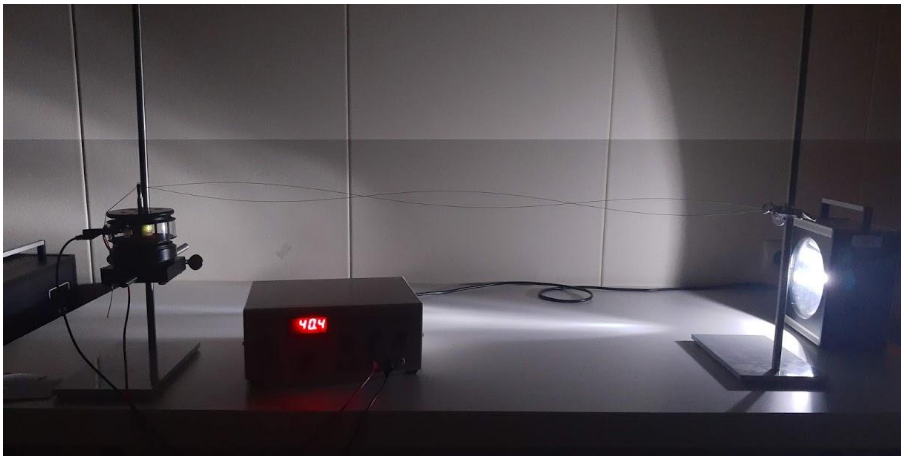
Melde's String Vibrator

Key words: string, vibration, wave, standing wave, oscillation



Equipment List:

1. PASCO mechanical vibrator
2. 1A signal generator (with 4Ω output) with power cable
3. Elastic string with loop on one end and banana plug on the other
4. 2 retort stands, 2 connector, 1 bar for retort stand
5. 2 banana plug cables
6. Strobe light with power cable

How to assemble and operate:

- Attach a connector piece to each retort stand. Put the bar in one of them.
- Attach the vibrator to the bar using the through-hole and screw in the base of the vibrator
- Clamp the banana plug on the string in the connector on the other retort stand
- Place stands about 1-1.5m apart, feed the string through the slot on top of the vibrator and then place the loop around the rod to fasten it. If need be the string can be wrapped around parts of the setup to tension
- Connect the vibrator to the 4Ω output of the signal generator using the banana plug cables
- Make sure the attenuation of the signal generator is set to 1x, the amplitude is turned completely up, the frequency range is set to 10-100 hz and the waveform type is set to sinusoidal, then turn it on
- Adjust the frequency until you find standing waves in the string
- **[EPILEPSY WARNING]** These phenomena can be seen more easily when a strobe lamp is used by having the strobe be pointed at or behind the string in a dark room, and the frequencies nearly matched. This will slow the vibration of the string down, making it more clear to see.

Description/Theory:
This demonstration illustrates harmonics and standing waves on a string. This could be accompanied by calculations on the board, using measurements made on-the-spot. The setup can be varied to show how the frequencies depend on the length and tension of the string: Greater length lowers the resonant frequency, whereas greater tension increases it. It can also be shown that if f is the frequency at which a single standing wave is encountered (so with no nodes except for at the ends) then there are resonant frequencies at $n*f$ for any integer n. It can also be shown that at these higher “modes” the nodes are indeed stationary, by pinching them and watching the part between the pinched point and the vibrator still resonate.

Comments/Notes:
Turning the room lights off may help visibility when using a strobe light. As mentioned above however, a clear epilepsy warning should be given before using the strobe light. In a more hands-on environment, a cool thing to do is to use a second set of banana plugs to hook the external trigger input of the strobe up to the 600Ω output of the signal generator to lock the light and sting in phase, making the string seem stationary, and then have students try to touch the string from both sides.