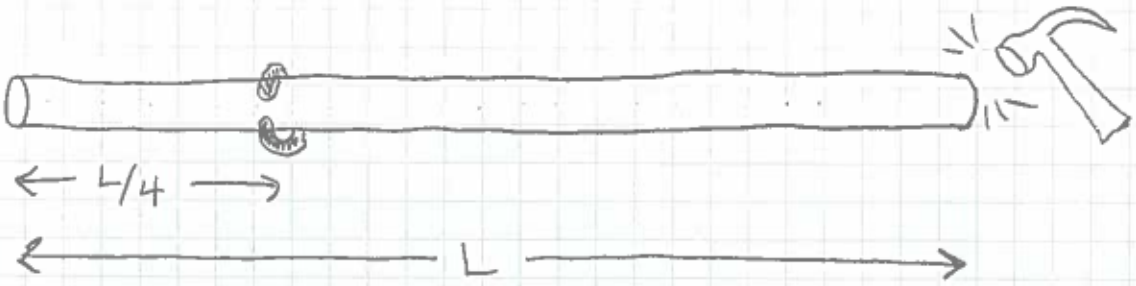


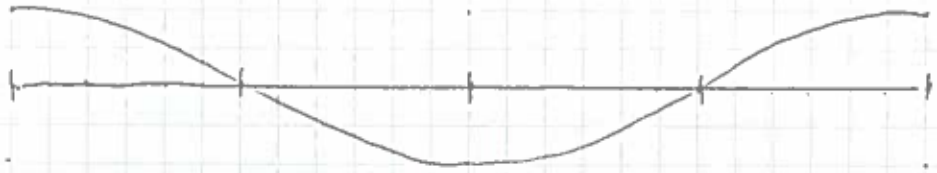
A long copper rod of length L is held firmly at a distance $\frac{L}{4}$ from the left end, then tapped on right end with a hammer. The rod rings with a faint, high pitch.

"Mon Dieu", exclaims Leopold, "5 octaves above middle C!"

How long is the rod?

First, we know that the rod's vibration

- has a node at $L/4$, where it is held
- has antinode at $x=0$, free left end
- has antinode at $x=L$, free right end



The longest wavelength satisfying these conditions is $\lambda = L$.

Next, we need to find the speed of longitudinal waves travelling through the rod. For long, thin objects, longitudinal waves move at

$$v = \sqrt{\frac{Y}{\rho}}$$

Y = Young's modulus

ρ = density

For copper

$$v = \sqrt{\frac{130 \times 10^9 \ N/m^2}{8960 \ kg/m^3}} = 3809 \ \frac{m}{s}$$