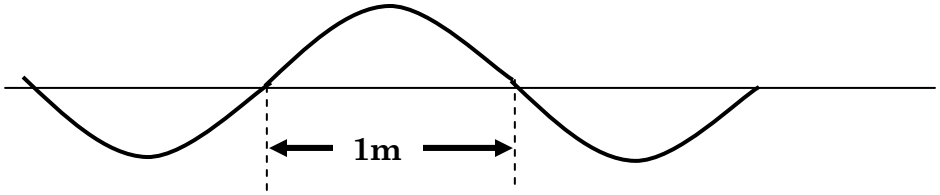
Physics 211 **Week 13**

Transverse Waves: Power Train Solutions



A long wire under tension is carrying the traveling wave illustrated above. A one meter section of the wire has a mass of 1 gram. The oscillation frequency is f = 256 Hz and the average power passing a point is 10 Watts. Find the tension on the wire and the wave amplitude.

A strategy: You can determine the wavelength from the sketch. From the oscillation frequency and wavelength you can find the propogation velocity. The expression for the average power can then be used to solve for the amplitude and the expression for the velocity of propagation can be used to solve for the tension.

The 1 meter section corresponds to one half wavelength which means λ = 2m.

$V = \lambda\ f = (2m)\times(256Hz) = 512m/s$

The mass density is given by:

$\mu = 1gm/m = 0.001\,kg/m$

We can now solve for the amplitude using:

$$\overline{P} = \tfrac{1}{2}\mu V(a\omega)^2 \Rightarrow a = \sqrt{\frac{2\overline{P}}{\mu V\omega^2}} = \sqrt{\frac{2\overline{P}}{\mu V(2\pi f)^2}} = \sqrt{\frac{2(10W)}{(0.001kg/m)(512m/s)(2\pi\times 256s^{-1})^2}} = 0.00389m$$

And the tension using:

$$V = \sqrt{\frac{T}{\mu}} \Rightarrow T = \mu V^2 = (0.001kg/m)\times(512m/s)^2 = 262\ N$$