Standing Waves

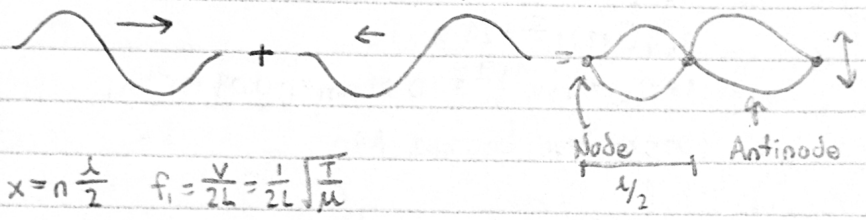
PH 112

$y_1(x,t) = a\sin(kx - \omega t)$

$y_2(x,t) = a\sin(kx + \omega t)$

$E(x,t) = a\sin(kx-\omega t) + a\sin(kx+\omega t) = a(\sin kx\cos\omega t - \cos kx\sin\omega t) +$
$a(\sin kx\cos\omega t + \cos kx\sin\omega t)$

$E(x,t) = A\cos\omega t \quad A = 2a\sin kx$



$x = n\frac{\lambda}{2} \quad f_1 = \frac{v}{2L} = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$

↑ fundamental frequency

Example #1

$\ell = 0.35\text{m}$

$f_1 = 392\text{ Hz}$

$v = ?$

$\ell(f = 440\text{ Hz}) = ?$

$\ell = \frac{\lambda_1}{2} \quad \lambda_1 = 2(.35) = 0.7\text{m}$

$v = \lambda_1 f_1 = 0.7(392) = \boxed{274.4\text{ m/s}}$

$f = \frac{v}{2\ell} \quad \ell = \frac{v}{2f} = \frac{274.4}{2(440)} = \boxed{0.31\text{ m}}$

Example #2

$\ell = 1.1\text{m}$

$m = 9\text{g} = .009\text{kg}$

$f_1 = 131\text{ Hz}$

$F_T = ?$

$f_{1-4} = ?$

$v = \sqrt{\frac{F_T}{\mu}} \quad F_T = v^2\mu = 288.2^2(.0082) = \boxed{679.6\text{ N}}$

$\lambda_1 = 2\ell = 2.2\text{m} \quad v = \lambda f = 2.2(131) = 288.2\text{ m/s}$

$\mu = \frac{m}{L} = \frac{.009}{1.1} = .0082\text{ kg/m}$

$f_1 = \boxed{131\text{ Hz}} \quad f_2 = \boxed{262\text{ Hz}} \quad f_3 = \boxed{393\text{ Hz}} \quad f_4 = \boxed{524\text{ Hz}}$