Using Snell's Law:

$$n_i \sin\theta_i = n_r \sin\theta_r$$

medium 1 medium 2

$$n = \frac{c}{v}$$ ← $3.00 \times 10^8 \frac{m}{s}$

$n = 1.00$ (air or vacuum)

critical angle: more dense to less dense ⇒ $\theta_r = 90°$
(θ_i) (high n) (low n)

PE/410

12. critical (θ_i) angle for ethyl alcohol

ethyl alcohol → air

$n_i = 1.362$

$\theta_i = ?$

$n_r = 1.00$

$\theta_r = 90°$

$$n_i \sin\theta_i = n_r \sin\theta_r$$

$$(1.362)\sin\theta_i = 1.00 \sin 90°$$

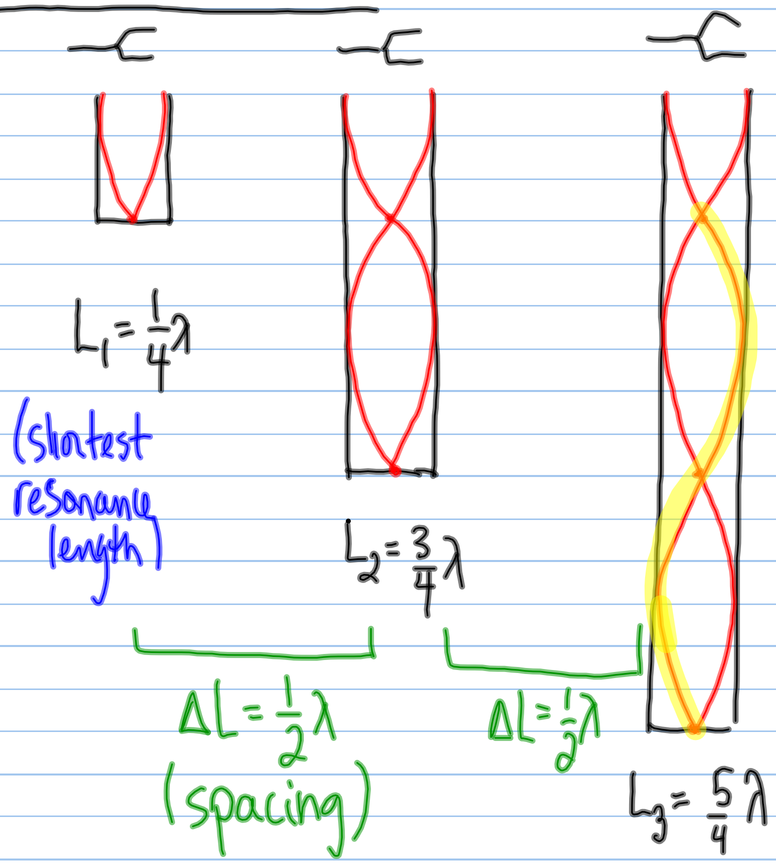
$$\sin\theta_i = \frac{1.00}{1.362}$$

$$\theta_i = \sin^{-1}\left(\frac{1.00}{1.362}\right)$$

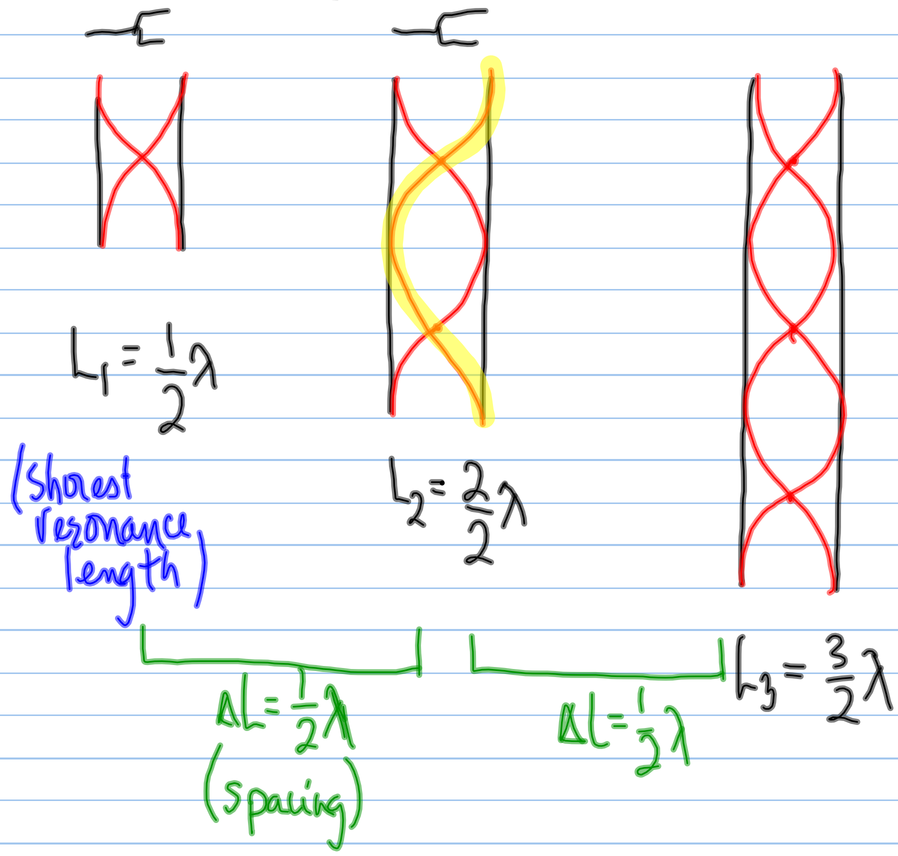
$$\theta_i \doteq 47.2°$$

Once the angle of incidence surpasses the critical angle, there will be total internal reflection. →

Closed Tube Resonance



Open Tube Resonance



mp|419

$L_1 = 9.0\,cm$

$T = 20°C$

a) $\lambda = ?$

b) L_2 and $L_3 = ?$

c) $f = ?$

Closed

a) $L_1 = \frac{1}{4}\lambda$ or $L_n = (2n-1)\frac{\lambda}{4}$

$L_1 = (2(1)-1)\frac{\lambda}{4}$

$L_1 = \frac{\lambda}{4}$

$9.0\,cm = \frac{1}{4}\lambda$

$\lambda = 4(9.0\,cm)$

$\lambda = 36.0\,cm$

b) $L_2 = \frac{3}{4}\lambda$

$L_2 = \frac{3}{4}(36.0\,cm)$

$L_2 = 27.0\,cm$

$L_3 = \frac{5}{4}\lambda$

$L_3 = \frac{5}{4}(36.0\,cm)$

$L_3 = 45.0\,cm$

c) Using the universal wave equation: $v = \lambda f$

$v = 331 + 0.59T$

$V = 331 + 0.59(20°C)$

$V = 331\,m/s + 11.8\,m/s$

$V \doteq 343\,\frac{m}{s}$

$v = \lambda f$

$f = \frac{V}{\lambda}$

$f = \frac{343\,\frac{m}{s}}{0.360\,m}$

$f \doteq 952\,Hz$

mp|425

Open

$f_1 = 330 Hz$

a) f_2 and $f_3 = ?$

b) $L_1 = ?$

$v = 344 m/s$

a) Open tube Resonance: $f_n = nf_1$

so $f_2 = 2f_1$ $\quad$ $f_3 = 3f_1$

$f_2 = 2(330Hz)$ $\quad$ $f_3 = 3(330Hz)$

$f_2 = 660Hz$ $\quad$ $f_3 = 990Hz$

b) $v = \lambda f$

$\lambda = \frac{v}{f}$

$\lambda = \frac{344 m/s}{330 Hz}$

$\lambda \doteq 1.04 m$

$L_1 = \frac{1}{2}\lambda$

$L_1 = \frac{1}{2}(1.04m)$

$L_1 \doteq 0.521m$

mp|426

What if it were closed? What would be the length of the tube if $f_1 = 330Hz$ and $v = 344m/s$?

$\lambda = 1.04m$
(wavelength is the same)

$L_1 = \frac{1}{4}\lambda$

$L_1 = \frac{1}{4}(1.04m)$

$L_1 \doteq 0.260 m$