

Closed Tube Resonance (one end is closed)



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



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

$$\Delta L = \frac{1}{2}\lambda$$

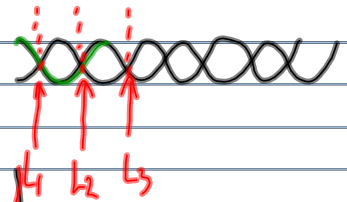
(spacing)



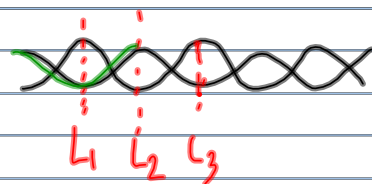
$$L_3 = \frac{5}{4}\lambda$$

$$\Delta L = \frac{1}{2}\lambda$$

(really just  
the distance  
between nodes)



Open Tube Resonance (both ends are open)



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



$$L_2 = \frac{2}{2}\lambda$$



$$\Delta L = \frac{1}{2}\lambda$$

$$L_3 = \frac{3}{2}\lambda$$

(spacing is the distance between antinodes!)

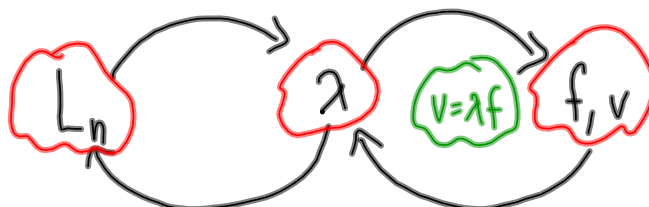
$$\Delta L = \frac{1}{2}\lambda$$

Resonance Summary

Closed tube: shortest tube  $L_1 = \frac{1}{4}\lambda$   $L_n = (2n-1)\frac{\lambda}{4}$   
 spacing  $\Delta L = \frac{1}{2}\lambda$   $f_n = (2n-1)f_1$

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Open tube: shortest tube  $L_1 = \frac{1}{2}\lambda$   $L_n = n\frac{\lambda}{2}$   
 spacing  $\Delta L = \frac{1}{2}\lambda$   $f_n = nf_1$



mp/419

closed

$$L_1 = 9.0 \text{ cm}$$

$$T = 20^\circ \text{C}$$

a)  $\lambda = ?$

b)  $L_2$  and  $L_3$

c)  $f = ?$

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

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

$$\lambda = 36 \text{ cm}$$

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

$$(L_2 = (2(2)-1) \frac{\lambda}{4})$$

$$L_2 = \frac{3}{4} (36 \text{ cm})$$

$$L_2 = 27 \text{ cm}$$

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

$$L_3 = \frac{5}{4} (36 \text{ cm})$$

$$L_3 = 45 \text{ cm}$$

c)  $f = ?$ ,  $v = ?$

$$v = 331 + 0.59 (20^\circ \text{C})$$

$$v = 331 + 11.8 \text{ m/s}$$

$$v = 343 \text{ m/s}$$

$$v = \lambda f$$

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

$$f = \frac{343 \text{ m/s}}{0.36 \text{ m}}$$

$$f = 952 \text{ Hz}$$

$$(9.5 \times 10^2 \text{ Hz})$$