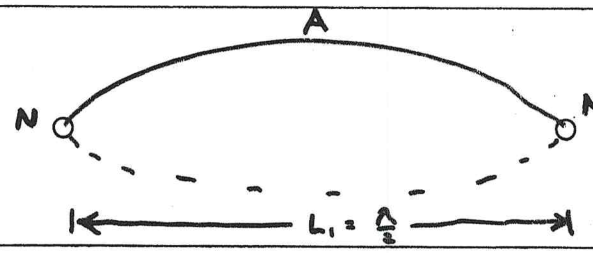
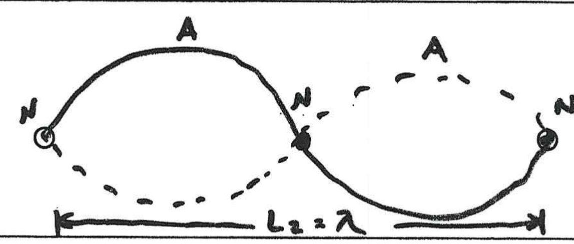
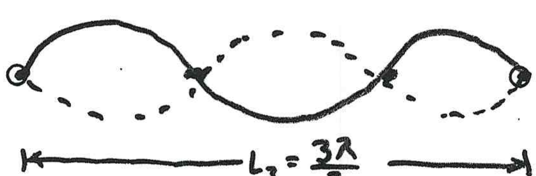
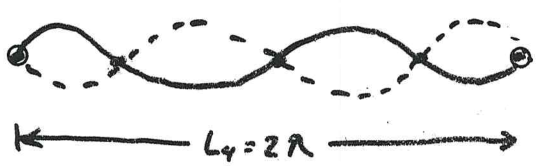
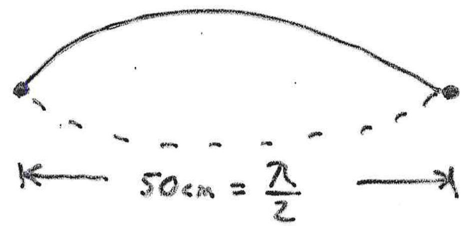
Standing Waves

	Closed/Fixed at Both Ends $L_n = \frac{n\lambda}{2}$
1st resonance (fundamental frequency) $L_1 = \frac{(1)\lambda}{2}$ $L_1 = \frac{\lambda}{2}$ ✓	
2nd resonance $L_2 = \frac{(2)\lambda}{2}$ $L_2 = \lambda$	
3rd resonance $L_3 = \frac{(3)\lambda}{2}$ ✓	
4th resonance $L_4 = \frac{(4)\lambda}{2}$ $L_4 = 2\lambda$	

(e.g. stringed instruments)

Example: a guitar string is 50 cm long and is vibrating at 550 Hz. Calculate the speed of the wave in the string. (at fundamental f)

n = 1



$50 = \frac{\lambda}{2}$

$2(50) = \lambda$

$\lambda = 100cm$

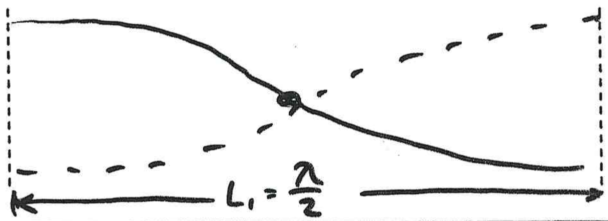
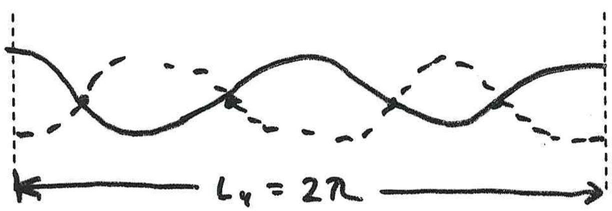
$\boxed{\lambda = 1 m}$ $f = 550 Hz$

$V = f\lambda$

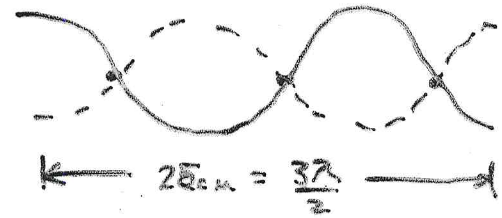
$= (550)(1)$

$\boxed{V = 550 \frac{m}{s}}$

Standing Waves… continued

	Open at Both Ends $L_n = \frac{n\lambda}{2}$
1st resonance (fundamental frequency) $L_1 = \frac{(1)\lambda}{2}$ $L_1 = \frac{\lambda}{2}$	
2nd resonance $L_2 = \frac{(2)\lambda}{2}$ $L_2 = \lambda$	
3rd resonance $L_3 = \frac{3\lambda}{2}$	
4th resonance $L_4 = \frac{4\lambda}{2}$ $L_4 = 2\lambda$	

Example: an open air column is vibrating at the third resonance length. The column is 25cm long and the air temperature is 28°C. Calculate the frequency of the sound.



$25 = \frac{3\lambda}{2}$

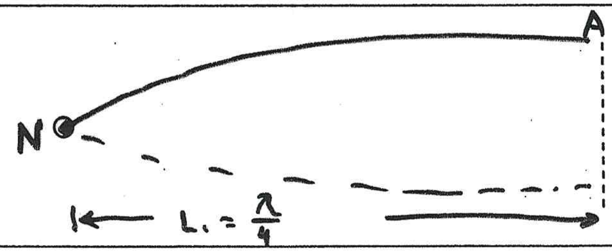
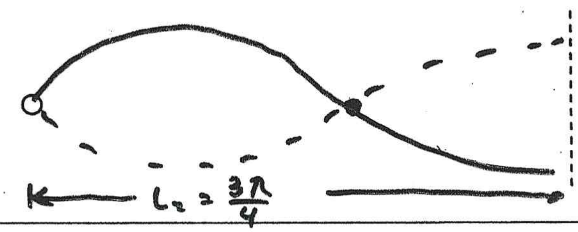
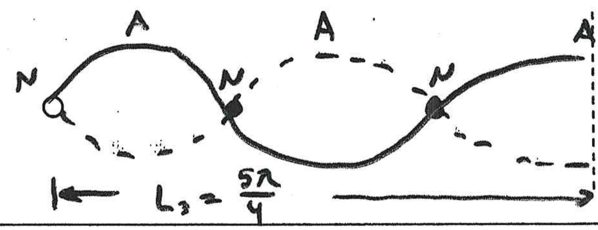
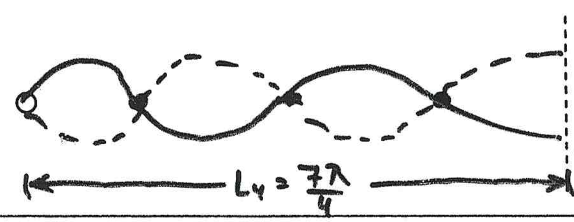
$2(25) = 3\lambda$

$\frac{2(25)}{3} = \lambda$

$\lambda = 16.7 cm$ $\quad f = ?$

$\lambda = 0.167 cm$ $\quad V_s = 332 + 0.6T$

Standing Waves...continued

	Closed/Fixed at One End & Open at the Other $L_n = \frac{(2n-1)\lambda}{4}$
1st resonance (fundamental frequency) $L_2 = \frac{(2(1)-1)\lambda}{4}$ $L_2 = \frac{\lambda}{4}$	
2nd resonance $L_2 = \frac{(2(2)-1)\lambda}{4}$ $L_2 = \frac{3\lambda}{4}$	
3rd resonance $L_3 = \frac{(2(3)-1)\lambda}{4}$ $L_3 = \frac{5\lambda}{4}$	
4th resonance $L_4 = \frac{(2(4)-1)\lambda}{4}$ $L_4 = \frac{7\lambda}{4}$	

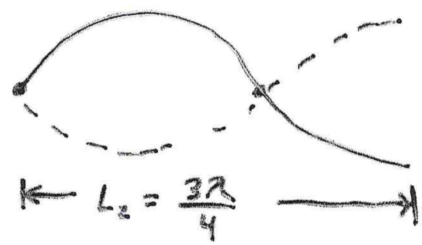
Example: a metal rod, fixed at one end, is vibrating at the 2nd harmonic and has a measured wavelength of 20 cm. Calculate the length of the rod. If the rod is vibrating 40 times every 2 seconds calculate the speed of the wave.

$f = \frac{40 \text{ cycles}}{2 s} = 20 Hz$

$\lambda = 20 cm = 0.2 m$

$v = f\lambda = (20)(0.2) = 4 \frac{m}{s}$

How long is the metal rod?



$L_2 = \frac{3(20 cm)}{4}$

$L_2 = 15 cm$ ✓