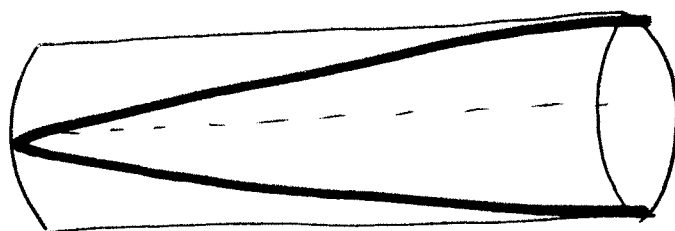


Harmonics of closed end instruments

EVEN HARMONICS ARE NOT POSSIBLE!



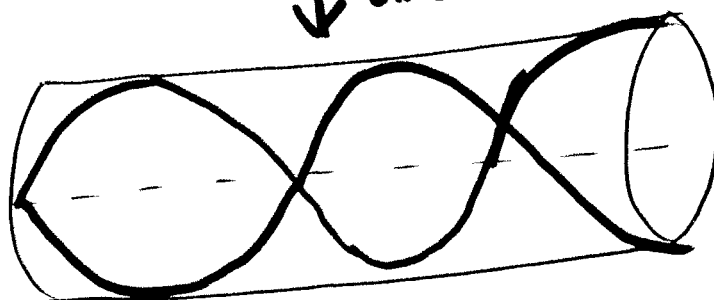
1st harmonic
 $(\frac{1}{4}\lambda)$

↓ Add 1 node and 1 antinode



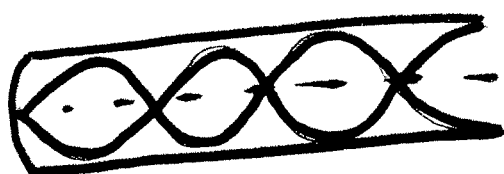
3rd harmonic
 $3f$
 $(\frac{3}{4}\lambda)$ or 3 "half humps"

↓ Add 1 node and 1 antinode



5th harmonic
 $5f$
 $(\frac{5}{4}\lambda)$ or 5 "half hump"

Sound sublevel 10
ex #1



$L = 80 \text{ cm}$

Harmonic # = 7th

$\lambda = \frac{45.7 \text{ cm}}{1}$

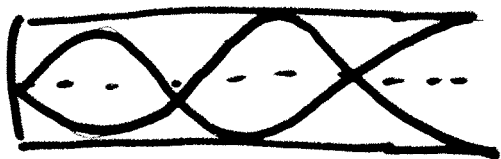
L contains $1\frac{3}{4}$ wavelengths

$L = 1.75\lambda$

$\lambda = \frac{L}{1.75} = \frac{80 \text{ cm}}{1.75}$

7 "half humps" = 7th harmonic

ex #2

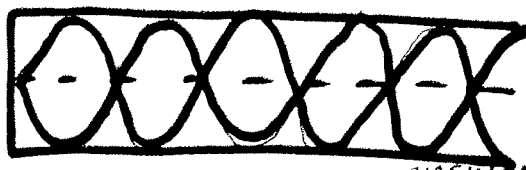


$$f = 540 \text{ Hz}$$

This is the 5th harmonic

↓ Determine the fundamental f

$$\frac{540}{5} = 108 \text{ Hz}$$



$$f = ? \quad \text{answer} = 1188 \text{ Hz}$$

This is the 11th harmonic

$$\downarrow \\ 11f = 11(108 \text{ Hz})$$