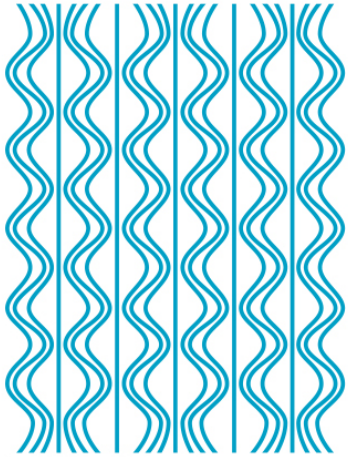
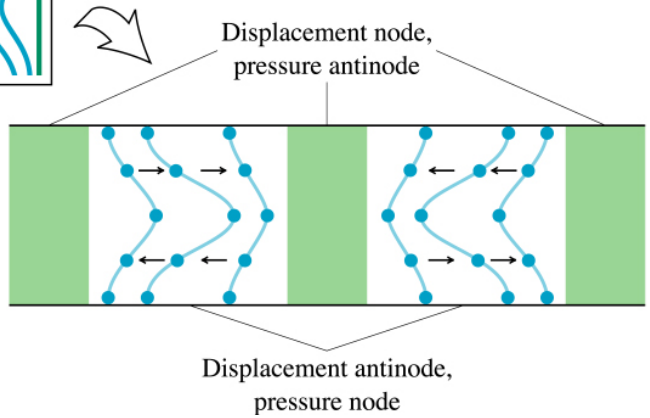
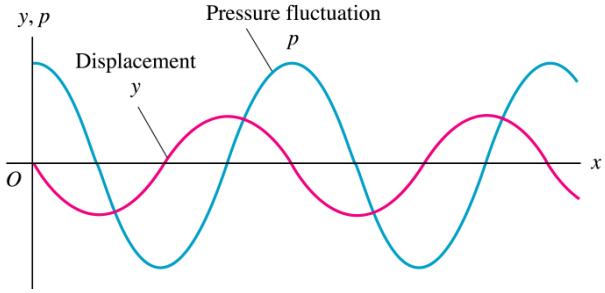
16-4. Standing Sound Waves







Displacement node: where particles have zero displacement
antinode: max

Pressure node: where pressure change is zero
antinode: max

Displacement node = Pressure antinode

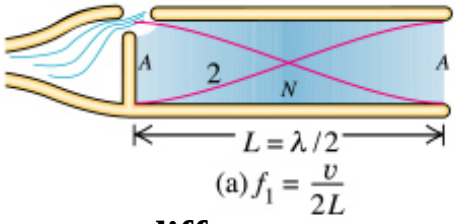
Displacement antinode = Pressure node

Open end:

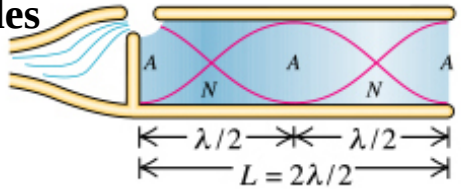
always a pressure node (or a displacement antinode),
since there is no pressure change

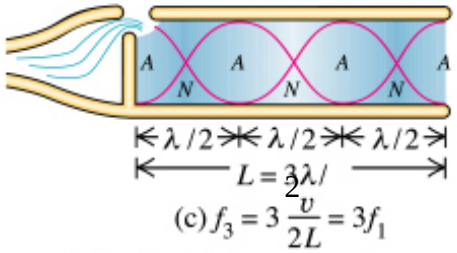
Open & Closed Pipes

Open pipe

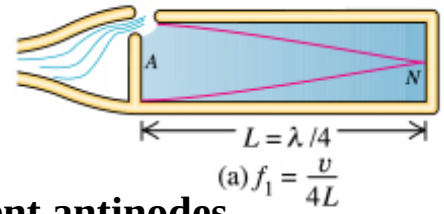


Both ends are
Pressure nodes – no pressure difference
Displacement antinodes

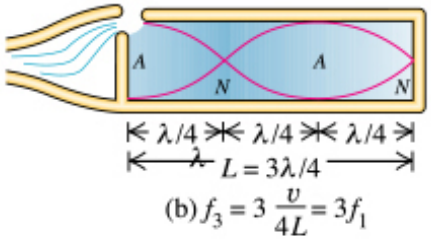




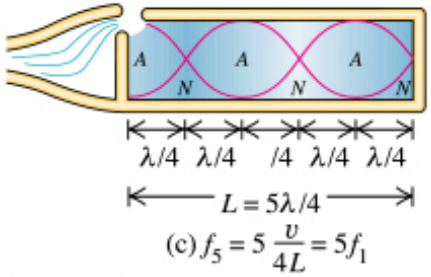
Closed pipe



Open end: displacement antinodes



Closed end: displacement node

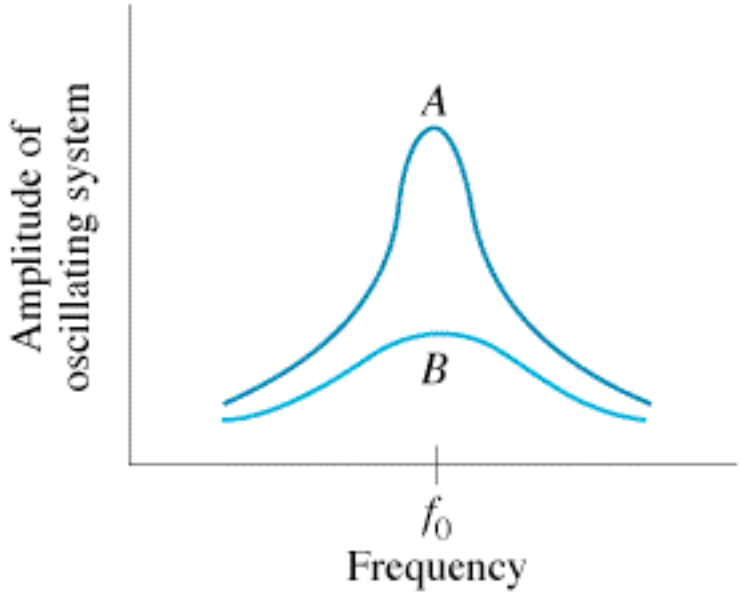


$$f_n = \frac{nv}{2L} = nf_1 \quad n=1,2,3,4\ldots$$

$$f_n = \frac{nv}{4L} = nf_1 \quad n=1,3,5\ldots$$

16-5. Resonance

Recall simple harmonic oscillator



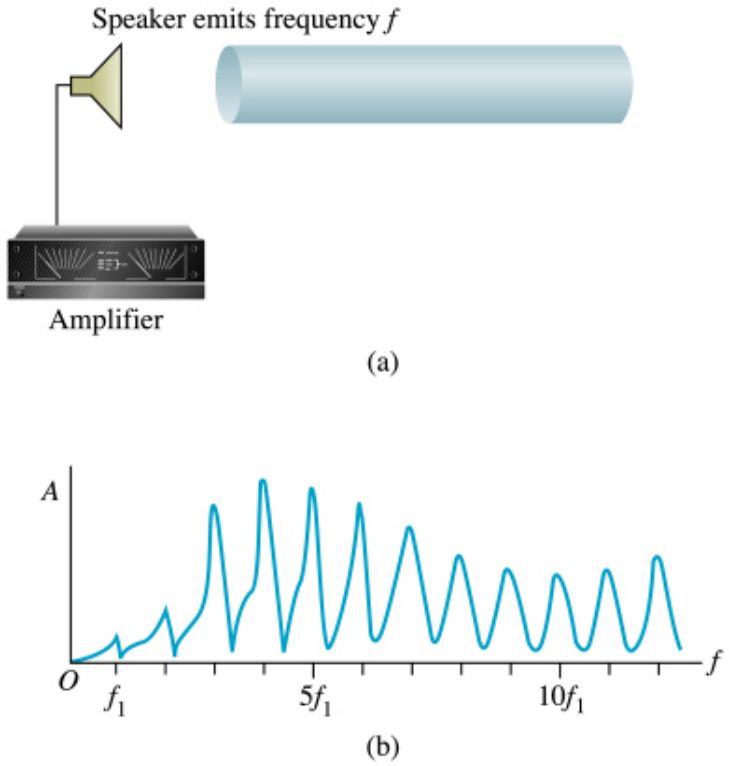
Natural frequency

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$ Intrinsic

Resonance:

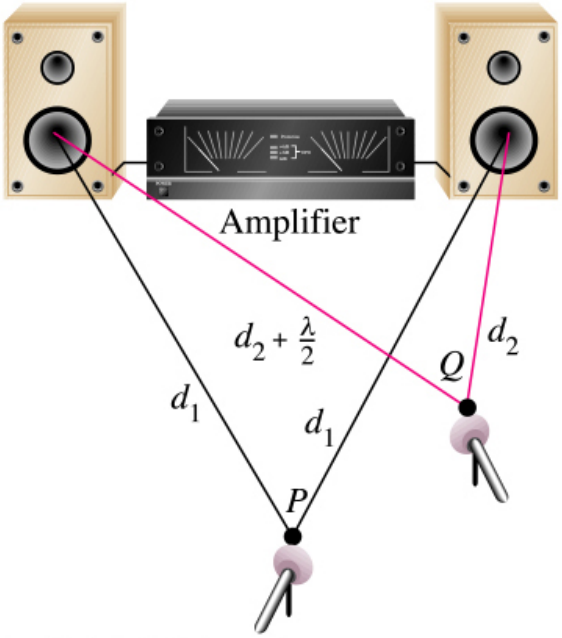
Very large increase in oscillation amplitude when $f=f_0$

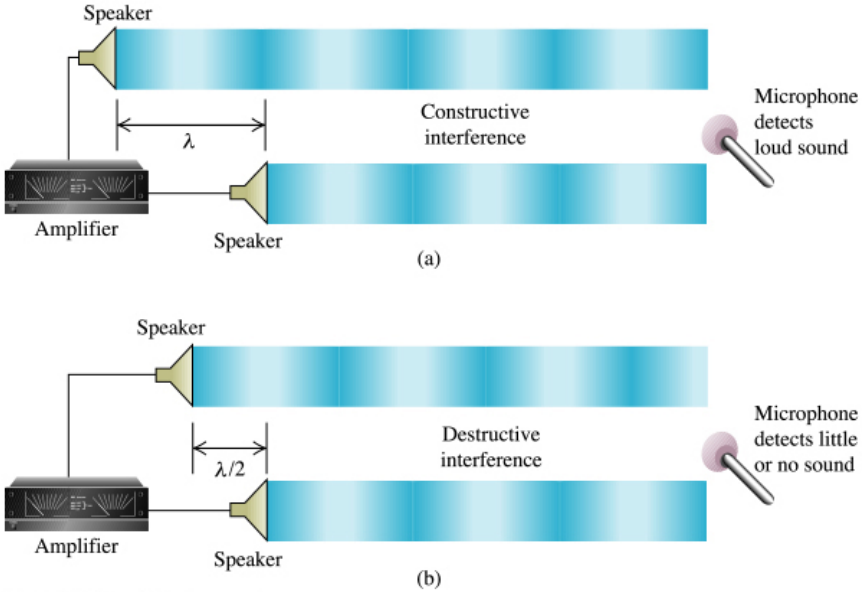
Resonance



When the driving frequency equals
a normal mode frequency of the system,
energy will be added into the system
and increase the oscillation amplitude.

16-6. Interference of Waves



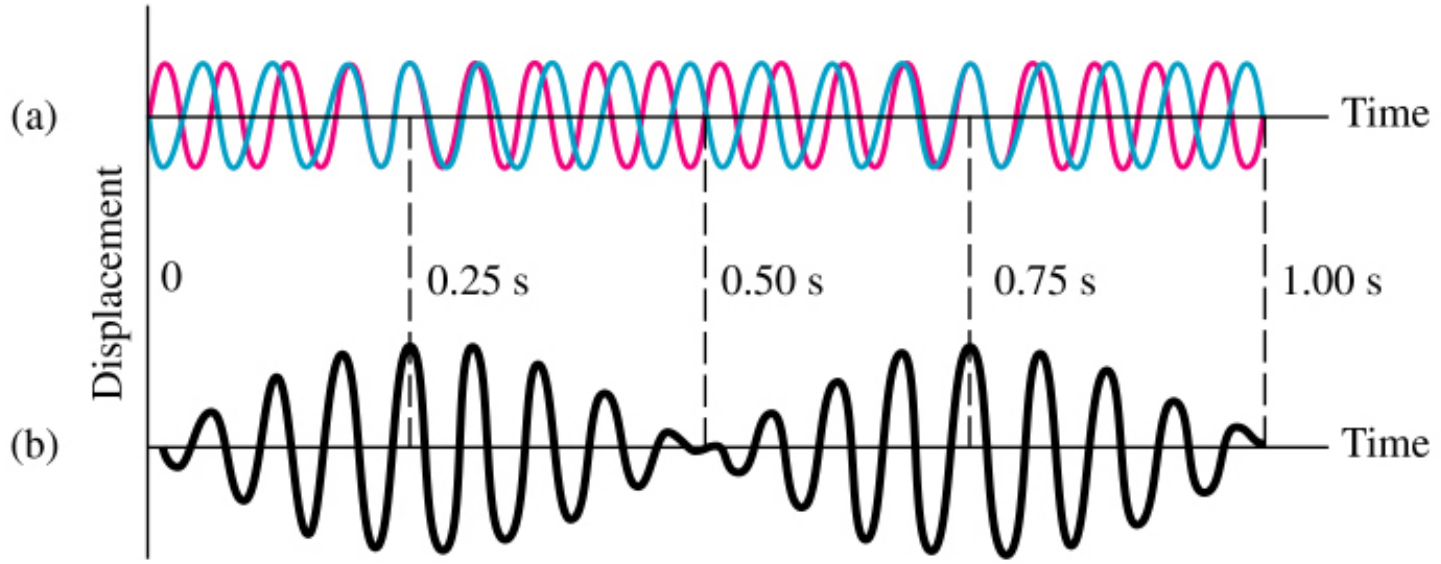


Path difference

λ/2, 3λ/2, 5λ/2… Destructive interference

0, λ, 2λ, 3λ... Constructive interference

16-7. Beats



Beats: Periodic amplitude variations caused by two waves with slightly different frequencies.

Beat frequency: $f_{beat} = |f_a - f_b|$