

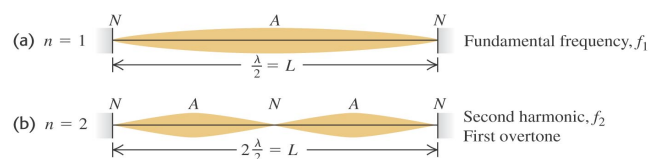
Lecture 7

Standing waves and Normal modes

Pre-reading: §16.1

Standing Waves

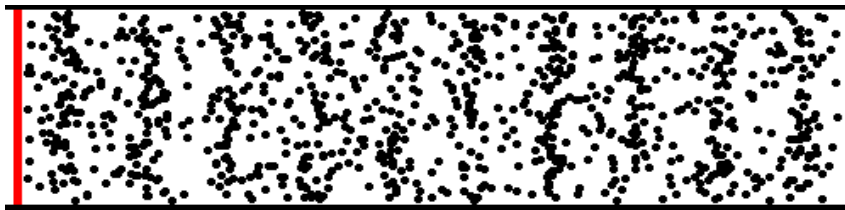
- Formed through reflection + superposition of waves moving in opposite directions
- Contains ‘nodes’ (no displacement) and ‘anti-nodes’ (maximum displacement)
- “Normal Mode”: property of a system in which all particles move sinusoidally at same freq.
- Lowest freq. normal mode: ‘fundamental’
Higher freq. normal modes: ‘harmonics’/‘overtones’



§15.8

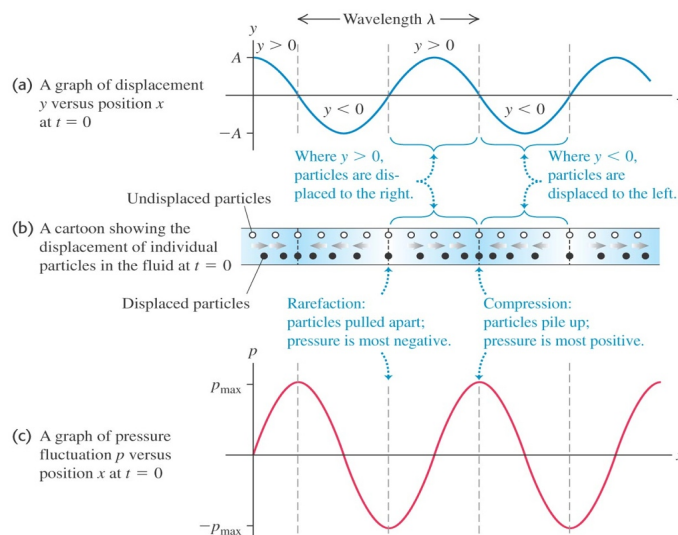
Longitudinal Waves

- Displacement is in direction of wave motion
- Need to distinguish particles from pressure



§16.1

Sound as Pressure Wave



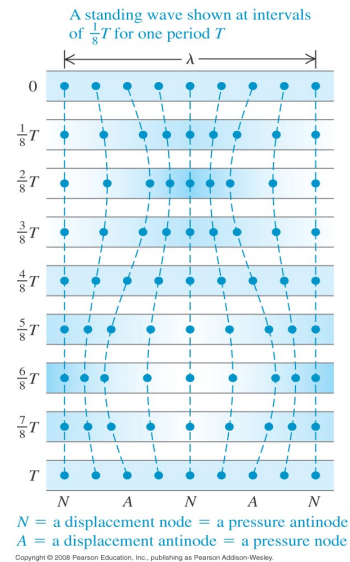
Three ways to
describe sound
waves

Pressure is 90°
out of phase with
displacement!

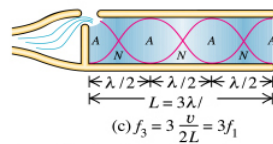
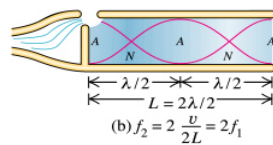
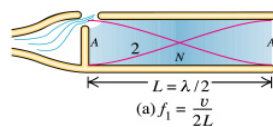
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Longitudinal Standing Waves

- Waves reflect at open or closed end
- Need to distinguish displacement of particles from pressure
- Node: no displacement
- Anti-node: **Time-averaged** location where max displacement is reached
- Displ. node = Pressure anti-node
Displ. anti-node = Pressure node

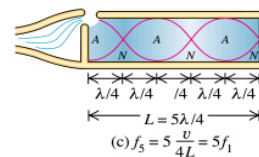
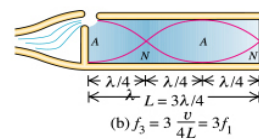
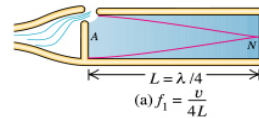


Open pipes



$$f_n = nv/(2L), \quad n = 1, 2, 3, \dots$$

Closed pipes



$$f_n = nv/(4L), \quad n = 1, 3, 5, \dots$$

§16.4

Next lecture

Sound waves
and
Perception of sound

Read §16.1–16.3