Vibrations and waves

- Maxima and nodes
- Frequency and period
  - Hertz (Hz) = 1 per second
  - Speed = wavelength \times frequency (v = \lambda u)
- Demonstration

Wavelength, frequency and velocity

- Maxima and nodes
- Frequency and period
  - Hertz (Hz) = 1 per second
  - Speed = wavelength \times frequency (v = \lambda u)
Longitudinal and transverse waves

- Transverse waves
- Longitudinal waves

Compressions and rarefactions in (longitudinal) sound waves

- The speed of sound depends on density
  - demonstration
Waves can be reflected

- Demonstration

Waves refract: why?

demonstration
Resonance is caused by forced vibrations

- Finding the resonant frequency
- Resonance in musical instruments
- Resonance in structures
  - Demonstration

Wave superposition

- Constructive interference
  - Demonstration
- Destructive interference

The superposition of two identical transverse waves in phase produces a wave of increased amplitude.

The superposition of two identical longitudinal waves in phase produces a wave of increased intensity.
Two-speaker interference

Beats

- Caused by waves with different frequencies
  - demonstration
What is a “standing wave”? 

Standing waves and harmonics

- Fundamental
- Second harmonic
  - Octave
- Third harmonic
  - octave + fifth
- Fourth harmonic
  - two octaves
If several harmonics are produced simultaneously...

- pure tone
- composite tone

Different instruments have different timbres

- Piano C
- Clarinet C
The Doppler effect

What’s going on?

- Stationary sound source
What’s going on?

- Moving sound source

What’s going on?

- Moving sound source
  - At the speed of sound
What’s going on?

- Moving sound source
  - Past the speed of sound

Bow waves and shock waves

- $v < v_w$
- $v = v_w$
- $v > v_w$
- $v$ greatly exceeds $v_w$