

Examples of Resonance

Batton's Pendulum - the pendulum that is the same length (i.e. has the same natural frequency) as the driven pendulum, has the largest amplitude.

Resonance in machinery (vehicle on a dirt road)

- loose components in the moving vehicle can vibrate and can do so with a large amplitude if their natural frequency is equal to the frequency of the car's vibration over the bumps.
- (fasten loose things down!)

Singing Wine Glasses.

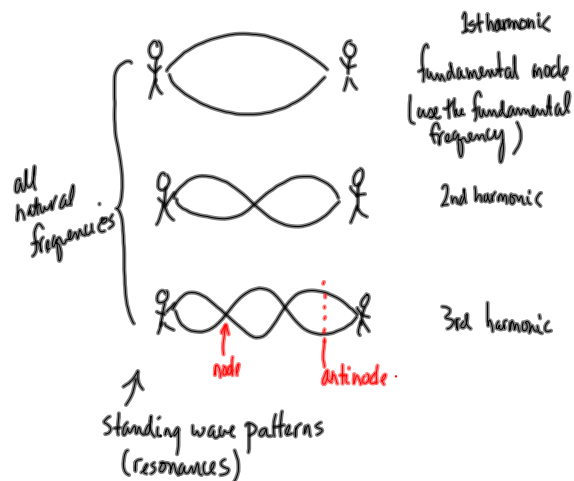
- the wine glass resonates with the periodic driving force (running your wet fingers around the rim of the glass)
- opera singers can break glass!

Mechanical Structure

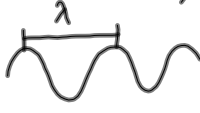
- structures like buildings + bridges must be strengthened to prevent damage due to resonance.
- strong winds / earthquakes can act as the driving force and the structure may resonate.
- resonance should be avoided
- Tacoma Narrows Bridge

Music

- organ pipes, trumpets, bugles, wind chimes (air vibrates in a tube with a resonant frequency)
- string instruments (piano, guitar, violin etc) (string that vibrates with a resonant frequency)



Microwaves

- water molecules have a natural resonant frequency of 2450 MHz λ
- microwaves are electromagnetic waves (wavelength is around 1cm or $f \approx 10^{10}$ Hz) 
- microwaves are reflected by metal surfaces and can form standing waves
- microwave is designed to resonate the microwaves as they are radiated from the magnetron tube.
- microwaves are absorbed by the water molecules in the food and cause the electrons to oscillate.
- producing kinetic energy \rightarrow food gets hot.
- microwaves are useful!

Electrical resonance

- radio signals \leftrightarrow frequencies must match (tuner used to match)

$$103.1 \text{ MHz}$$

$$103.1 \times 10^6 \text{ Hz}$$

Quartz Oscillators

- quartz is a material that exhibits the piezoelectric effect.
- pressure on a quartz crystal causes one side to become positive + the other negative.
- used in AC circuit \Rightarrow resonance occurs in the circuit when the oscillating voltage matches the natural vibration of the crystal.
- used in microphones, + pressure sensors
- very precise (used in electronic clocks + watches)

Greenhouse Effect.

- resonance within the greenhouse gases like CO_2 .