Mechanical waves

Mechanical waves

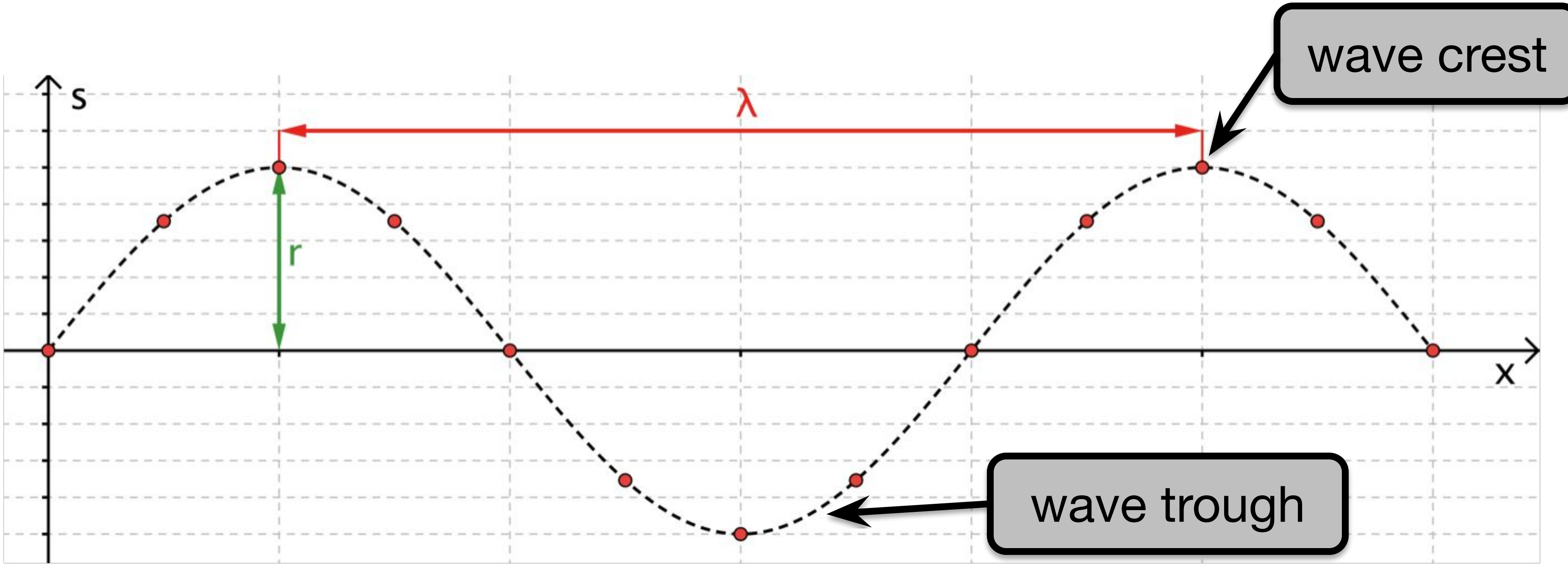
Wave: a disturbance travelling through a medium in a certain direction via oscillators

Properties of mechanical waves:

- transmit energy (not mass)
- oscillators oscillate but do not move from their mean position
- neighbouring oscillators are out of phase
- need a medium to travel

Source: Roger McLassus (2006). https://commons.wikimedia.org/wiki/File:2006-01-14_Surface_waves.jpg [17.10.2015].

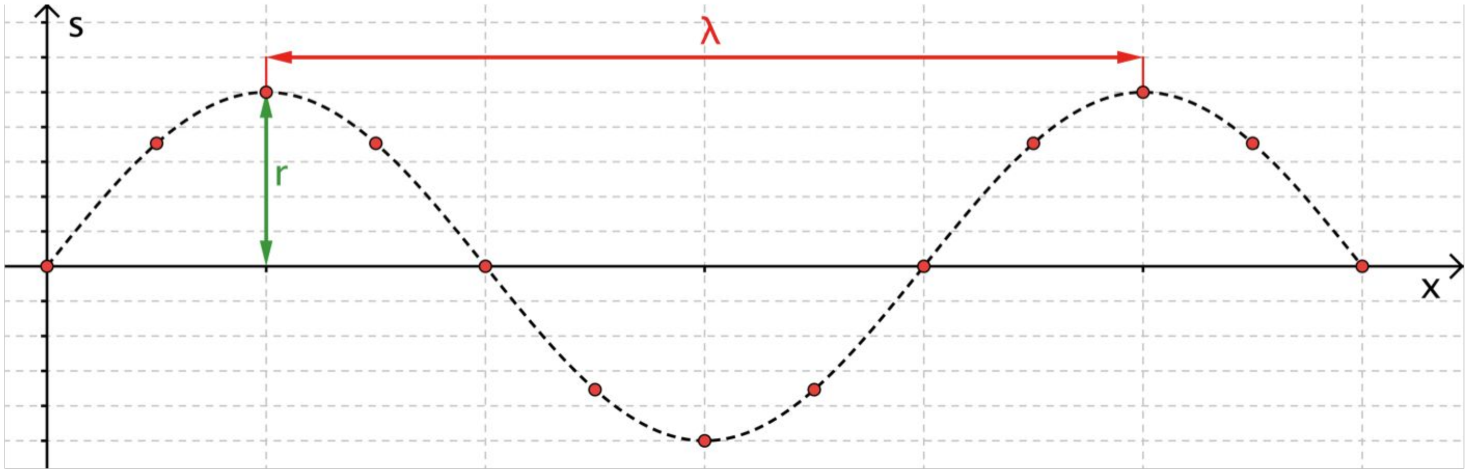
Harmonic waves



- wavelength λ = distance between two subsequent oscillators which are in phase (e.g. two subsequent wave crests)

- amplitude r of the wave = amplitude of the oscillators

Harmonic waves

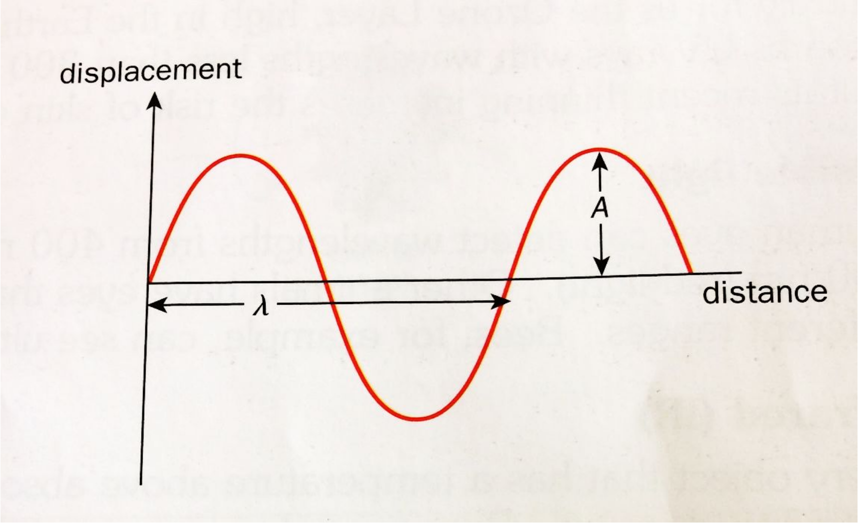


- all oscillators are harmonic oscillators
- all oscillators have the same period, frequency and amplitude (without damping)
- **frequency *f*** of the wave = frequency of the oscillators
- **speed *c*** of the wave:

$$c = \frac{\Delta x}{\Delta t} = \frac{\lambda}{T} \Rightarrow c = \frac{\lambda}{T} \quad \text{or} \quad c = \lambda \cdot f$$

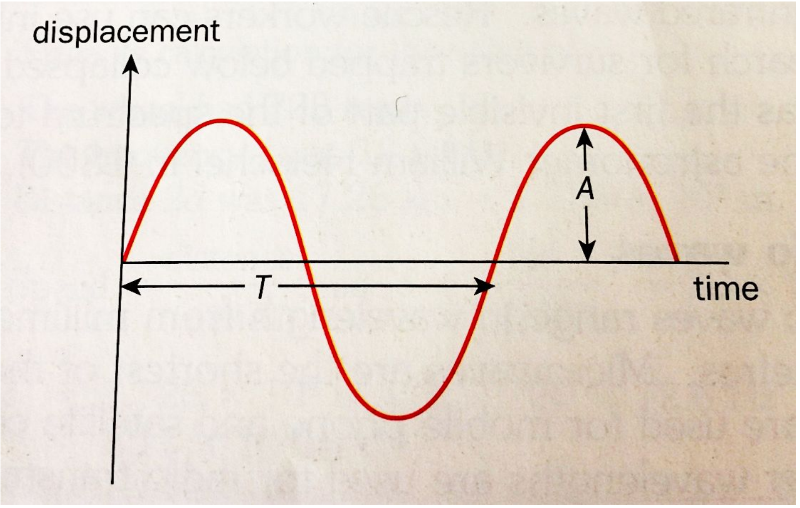
Using sine curves to analyse waves (pg. 129)

displacement-distance graph of wave motion:



- snapshot of positions of all oscillators that transmit a wave at one instant in time
- shows amplitude (A) and wavelength (λ) of the wave

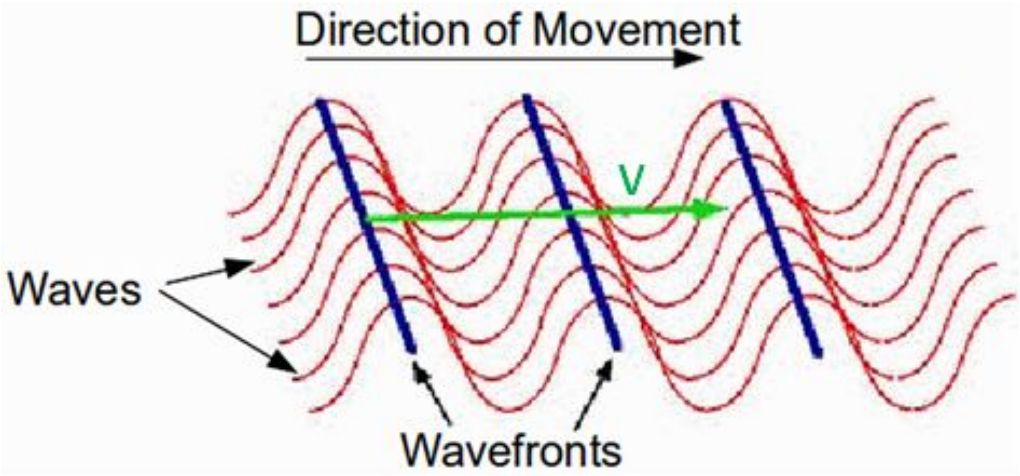
displacement – time graph of an oscillator propagating a wave:



- shows amplitude (A) and period (T) of all individual harmonic oscillators of the wave
- If oscillators are harmonic:

$$f_{wave} = f_{oscillator}$$

Wavefronts (pg.123)



- imaginary lines which join identical points (oscillators) of several waves which are in phase (in the same phase of their motion)
- eg. all crests or troughs
- show in which way a wave is moving

Energy and intensity (pg. 126-127)

Energy

- the energy of the wave is the sum of energies of the single oscillators
- proportional to the amplitude (r) squared
- proportional to the frequency squared

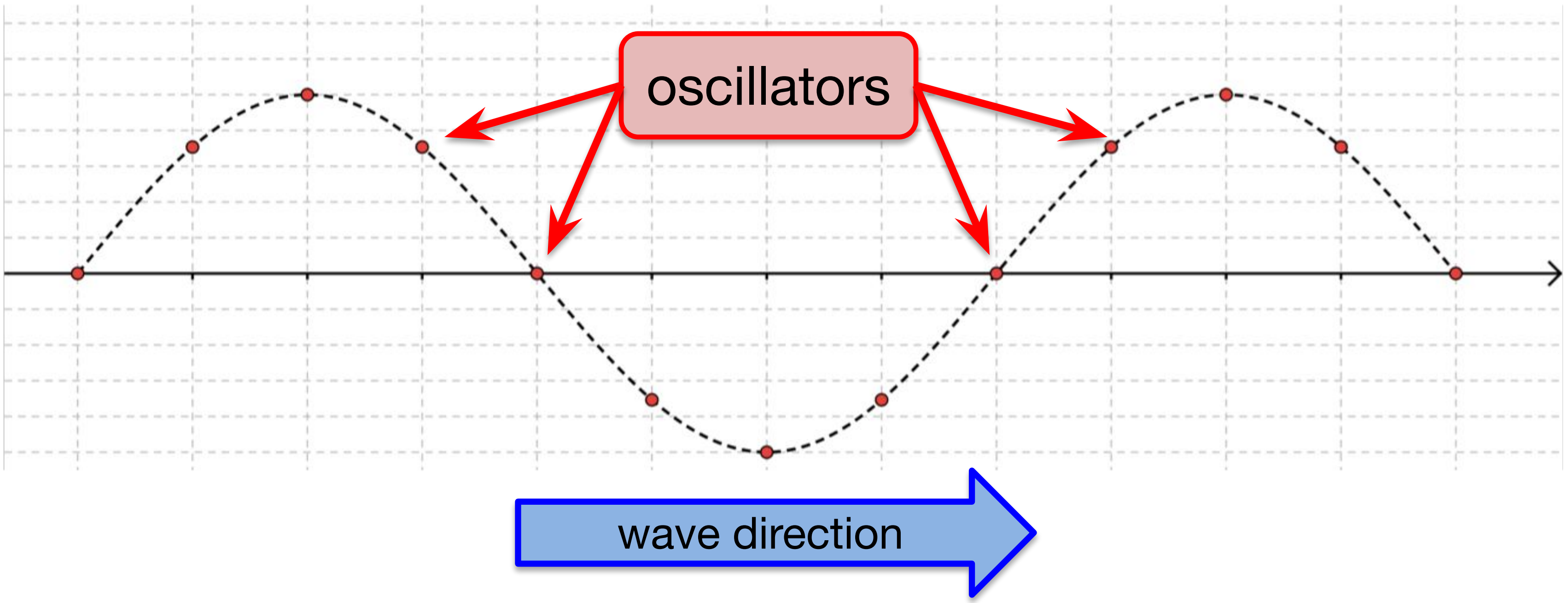
$$E = \frac{m \cdot r^2 \cdot \omega^2}{2}$$

Intensity (unit: W/m^2)

$$\text{intensity} = \frac{\text{total power transmitted}}{\text{total area through which the waves pass}} \quad \text{or} \quad I = \frac{P}{A} = \frac{P}{4\pi r^2}$$

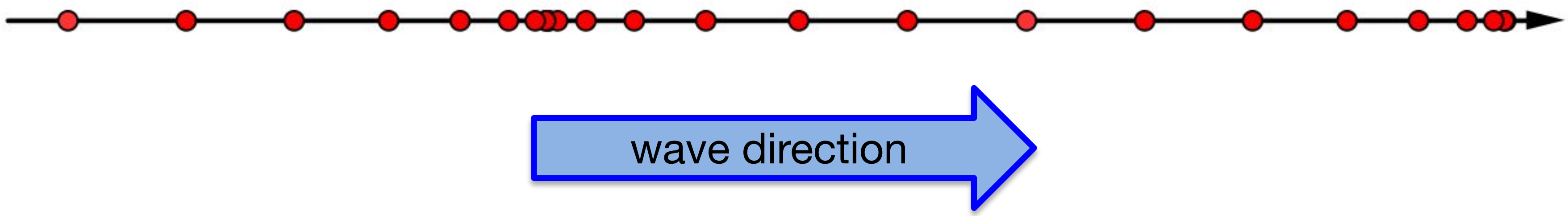
Transverse waves

[Types of mechanical waves]



The direction of vibration of the particles is perpendicular to the direction of propagation of the wave.

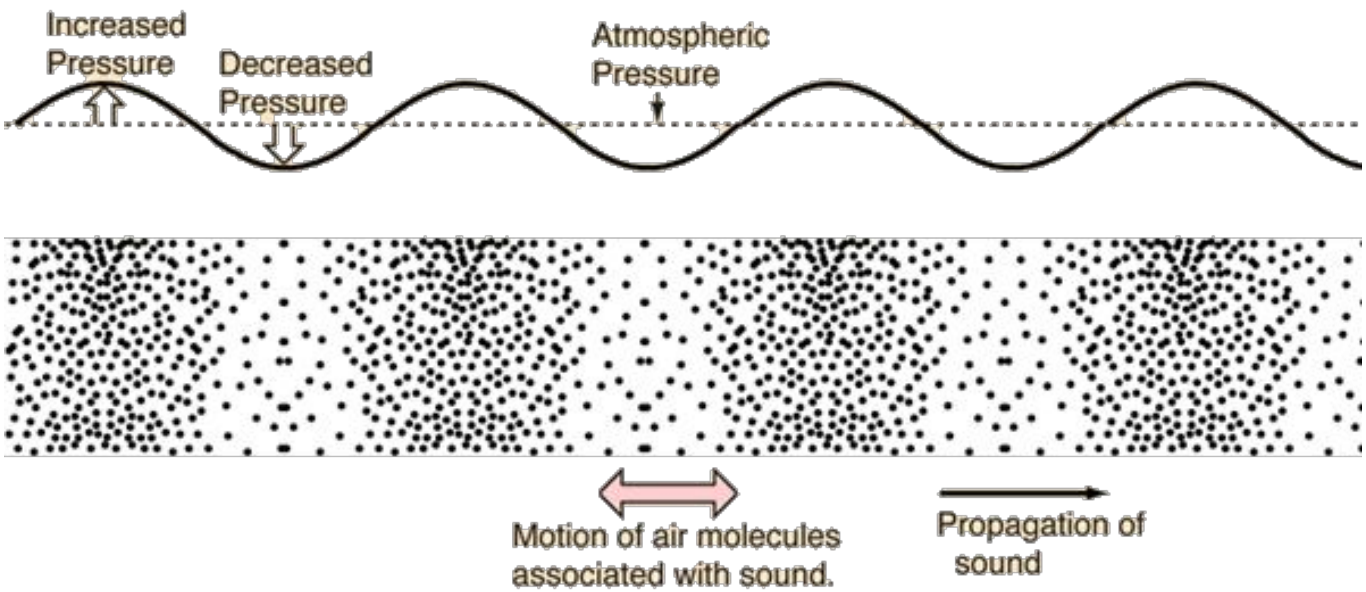
Longitudinal waves



The direction of vibration of the particles is parallel to the direction of propagation of the wave.

Pattern of compression (particle spacing decreases) and rarefaction (particle spacing increases)

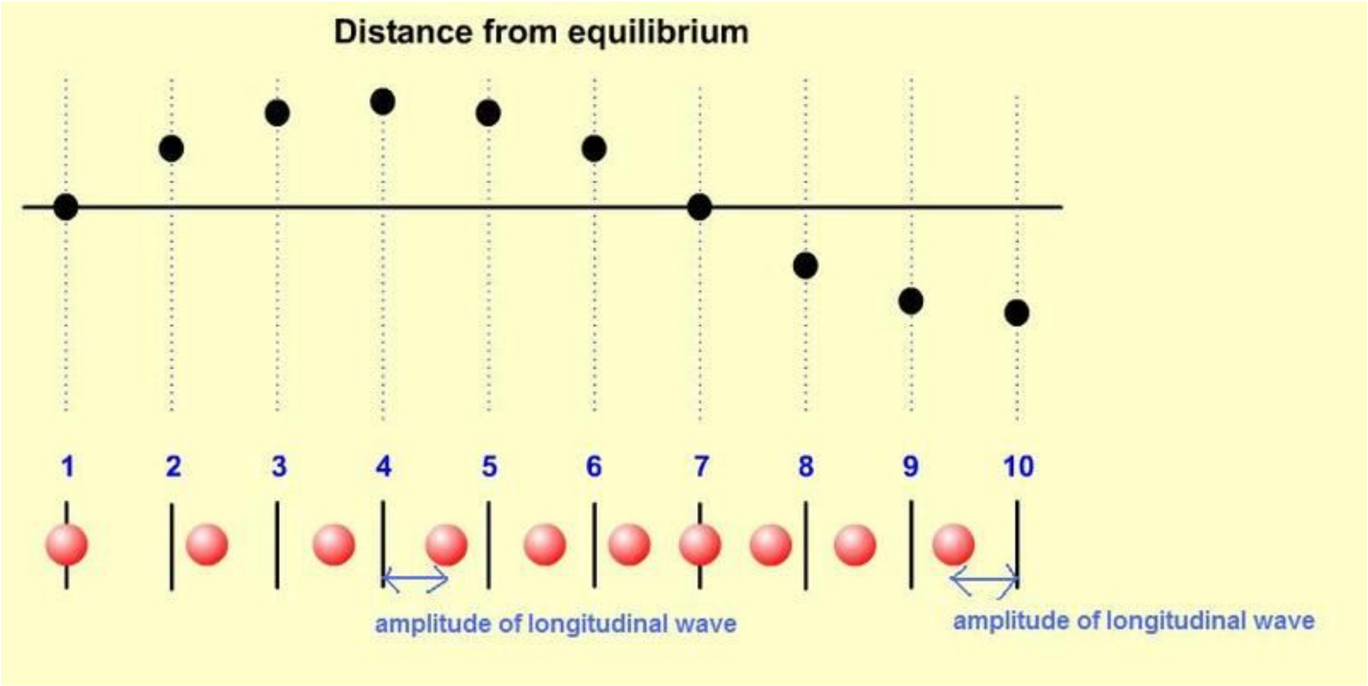
Using sine curves to analyse longitudinal waves



1) <u>pressure-distance graphs:</u> show instantaneous positions of pressure **peaks (maximum compressions)** and **troughs (maximum rarefactions)** at a point in time

http://hyperphysics.phy-astr.gsu.edu/hbase/Sound/tralon.html

Using sine curves to analyse longitudinal waves



2) <u>displacement (from equilibrium) – distance graph:</u>

- shows instantaneous positions of oscillators relative to their equilibrium position at a point in time

https://funwaves.wikispaces.com/5.+Longitudinal+wave