

add two waves at a point and you get everything from a plucked string to a tuned instrument

Progressive waves *

- a progressive wave carries a disturbance one way continuously, without damping, particle to particle
- every particle does the same S.H.M.: same amplitude, period, frequency, phase shifting steadily along
- energy and momentum transfer along the wave; no matter is carried along
- particles rest only at their extreme positions, move fastest through their own mean position



beads on a string: each does the same S.H.M. on its own track, a little behind the one before it; crest, trough, A and λ named, the wave moves on at v

Speed of a wave: elastic over inertial *

any mechanical wave

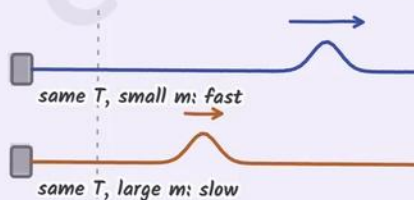
$$v = \sqrt{\frac{\text{elastic property}}{\text{inertial property}}}$$

transverse wave on a string, tension T , mass per unit length m

$$v = \sqrt{\frac{T}{m}}$$

longitudinal wave in a fluid, bulk modulus B , density ρ

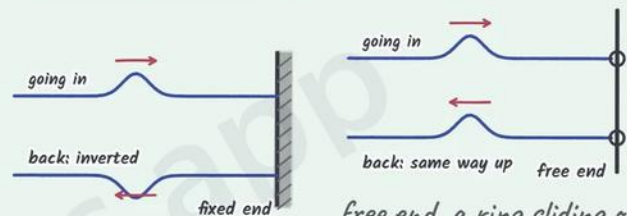
$$v = \sqrt{\frac{B}{\rho}}$$



two strings at the same tension, flicked together: the pulse on the heavier one (larger m) has gone less far
the medium sets v : stiffer is faster, more inertia is slower. the source sets n , and $\lambda = v/n$ follows

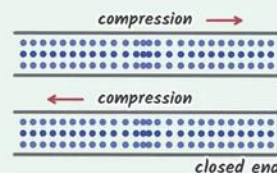
Reflection of waves

- rigid support (denser medium): crest reflects as trough, a π phase change on reflection
- free end (rarer medium): crest reflects as crest, no phase change at all
- speed, wavelength, frequency stay the same on reflection, only phase can change
- sound: a compression returns from a closed end as a compression
- from an open end of a pipe it returns as a rarefaction
- a sonometer wire is fixed at both ends: every reflection carries a π phase change

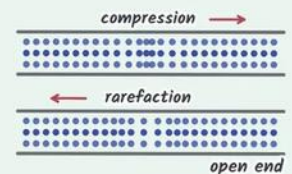


rigid support: the pulse comes back inverted

free end, a ring sliding on a rod: it comes back the same way up



closed end of a pipe: a compression comes back a compression



open end: a compression comes back a rarefaction