16.1. Superposition

Superposition: When two or more waves overlap, the resultant is simply the algebraic sum of their separate displacements.

Wave 1: $y_1(x,t) = A\cos\big(\overbrace{2\pi\left(\frac{x}{\lambda_1} - f_1 t\right) + \phi_1}^{\text{"phase"}}\big)$

$y_2(x,t) = A\cos\left(2\pi\left(x/\lambda_2 - f_2 t\right) + \phi_2\right)$

$y_{total} = y_1(x,t) + y_2(x,t)$.

Q: How do you actually do that sum?

A: In general, it's hard, but there are some easy important cases

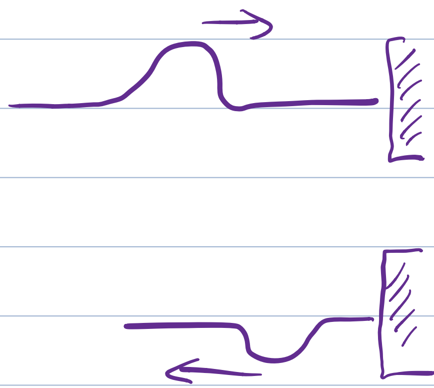
- Standing waves (opposite directions)
- beats (different frequencies)
- interference & diffraction (different distances)

(Examples – Mathematica)

16.2 Standing Waves

Reflection:

Rigid Wall



inverted

Free End

Not inverted

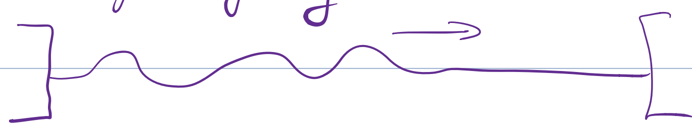
(demo - long spring)

Two ideas:

1) Physics sets wave speed v
2) Boundary conditions set allowed λ

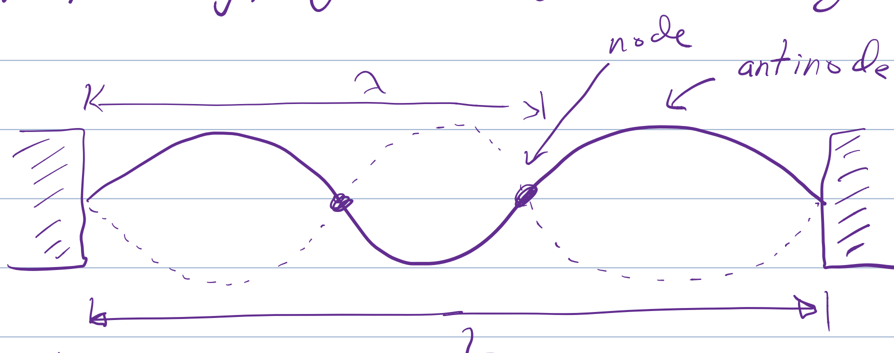
Relate them with $v = \lambda f$.

Make a right-going wave



It reflects back

If the f and v values are chosen appropriately, you can get a standing wave



Particles move up and down in simple harmonic motion.

Not all f's work — need nodes at each end. Use pictures.