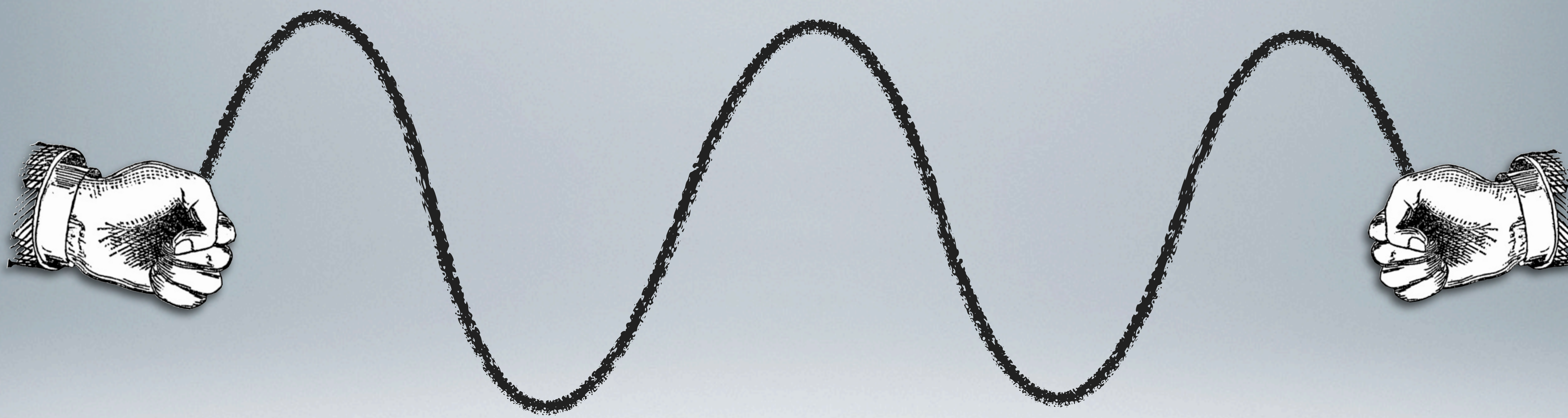
WAVE PROPERTIES

2012 Lecture Notes

WAVES AND HARMONIC MOTION



SIMPLE HARMONIC MOTION

Any vibrating system where the restoring force is proportional to the negative of the displacement is in simple harmonic motion (SHM), and is often called a simple harmonic oscillator.

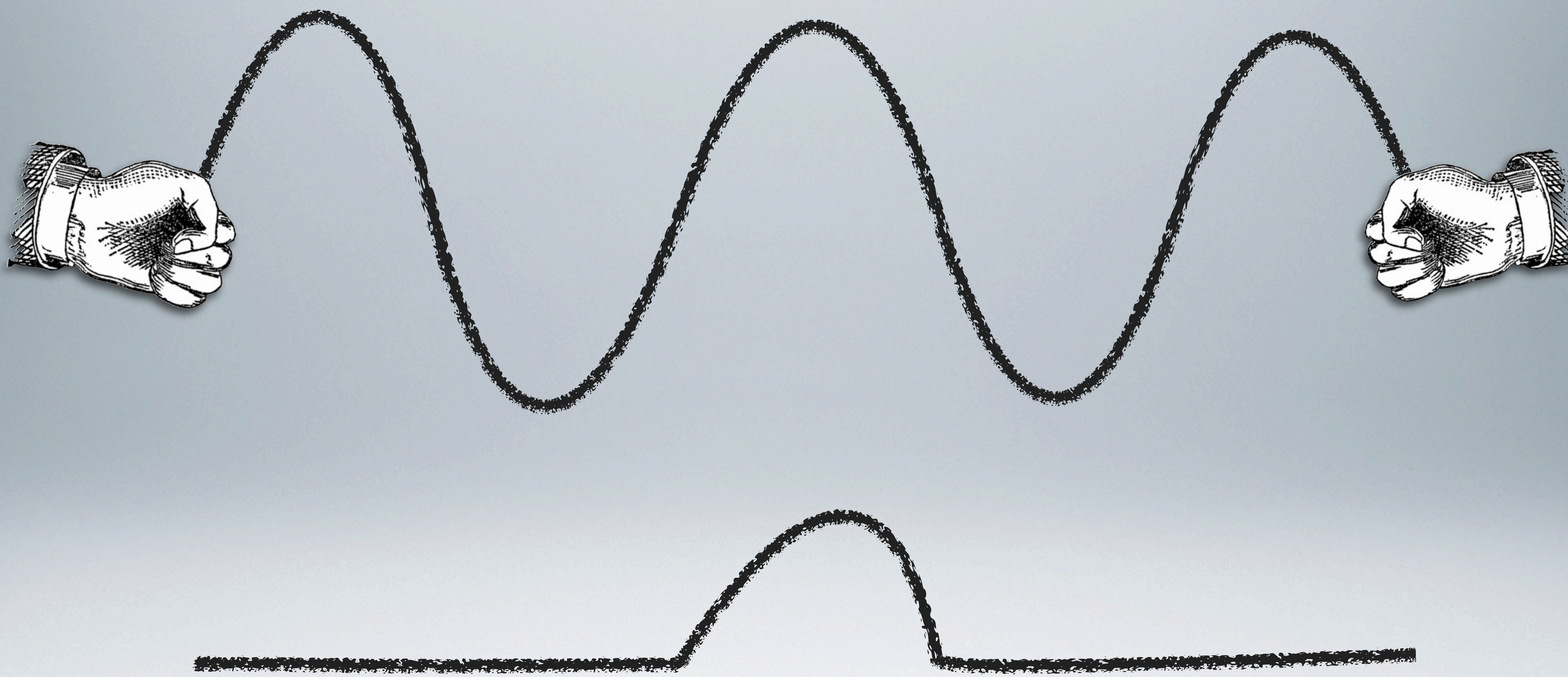
WAVE

- A periodic transfer of energy through a material or field with no net displacement to the medium.

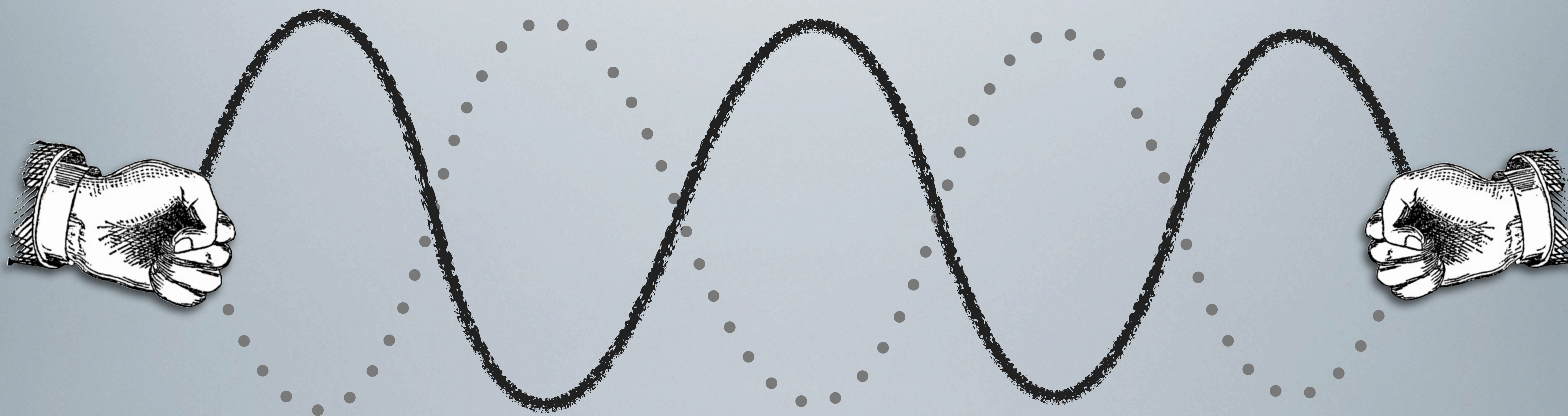
MEDIUM

- The "material" the wave is passing through.

PULSE / TRAVELING WAVE

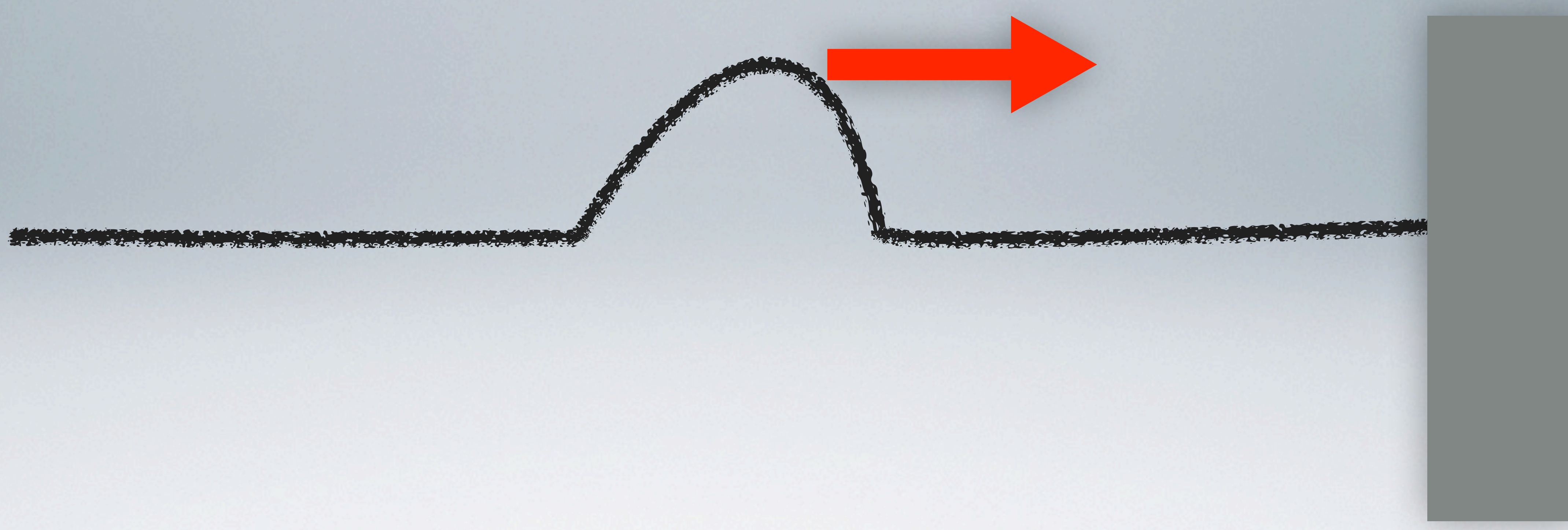


STANDING WAVE

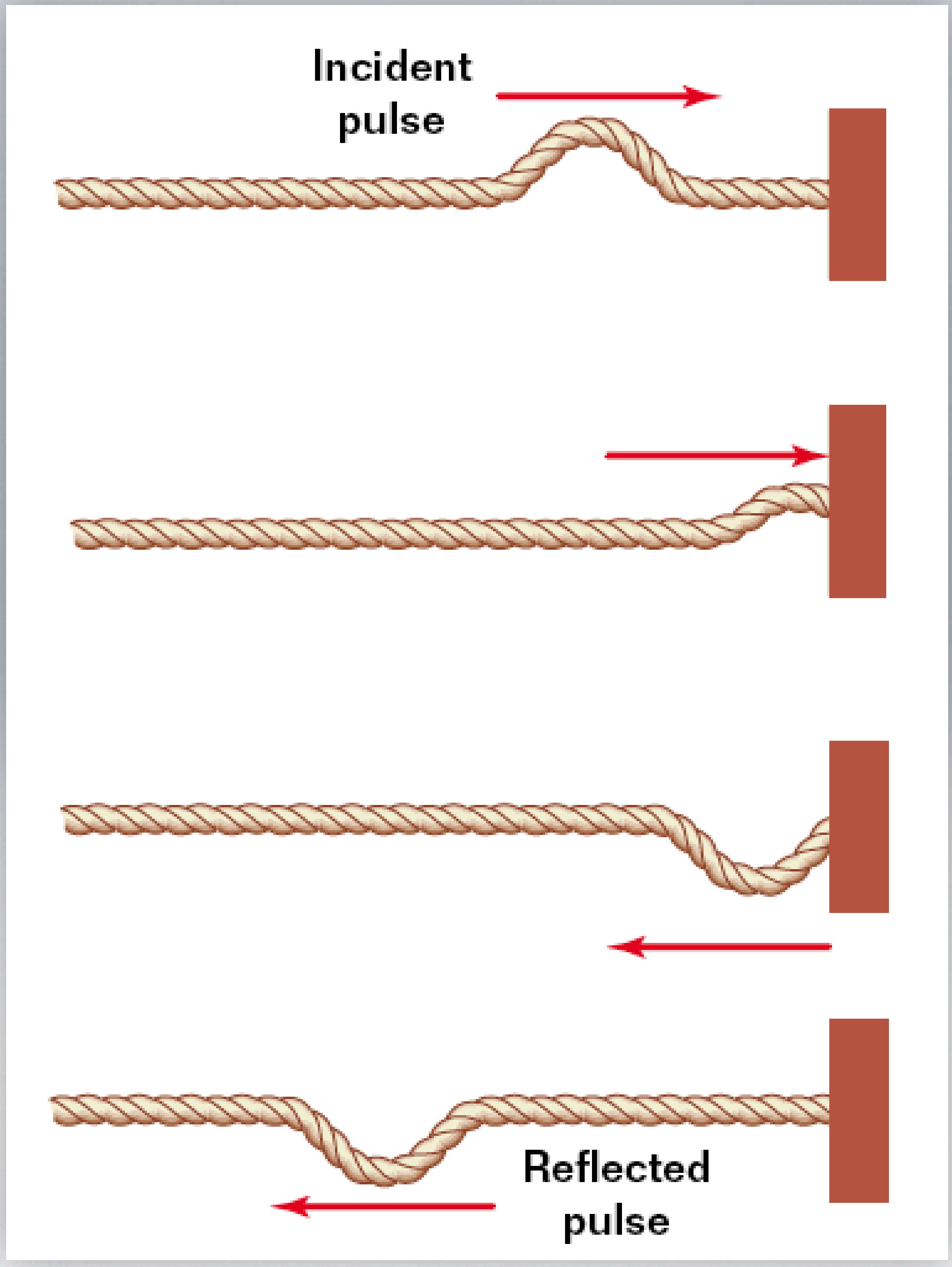


- The "parts" of the wave are stationary

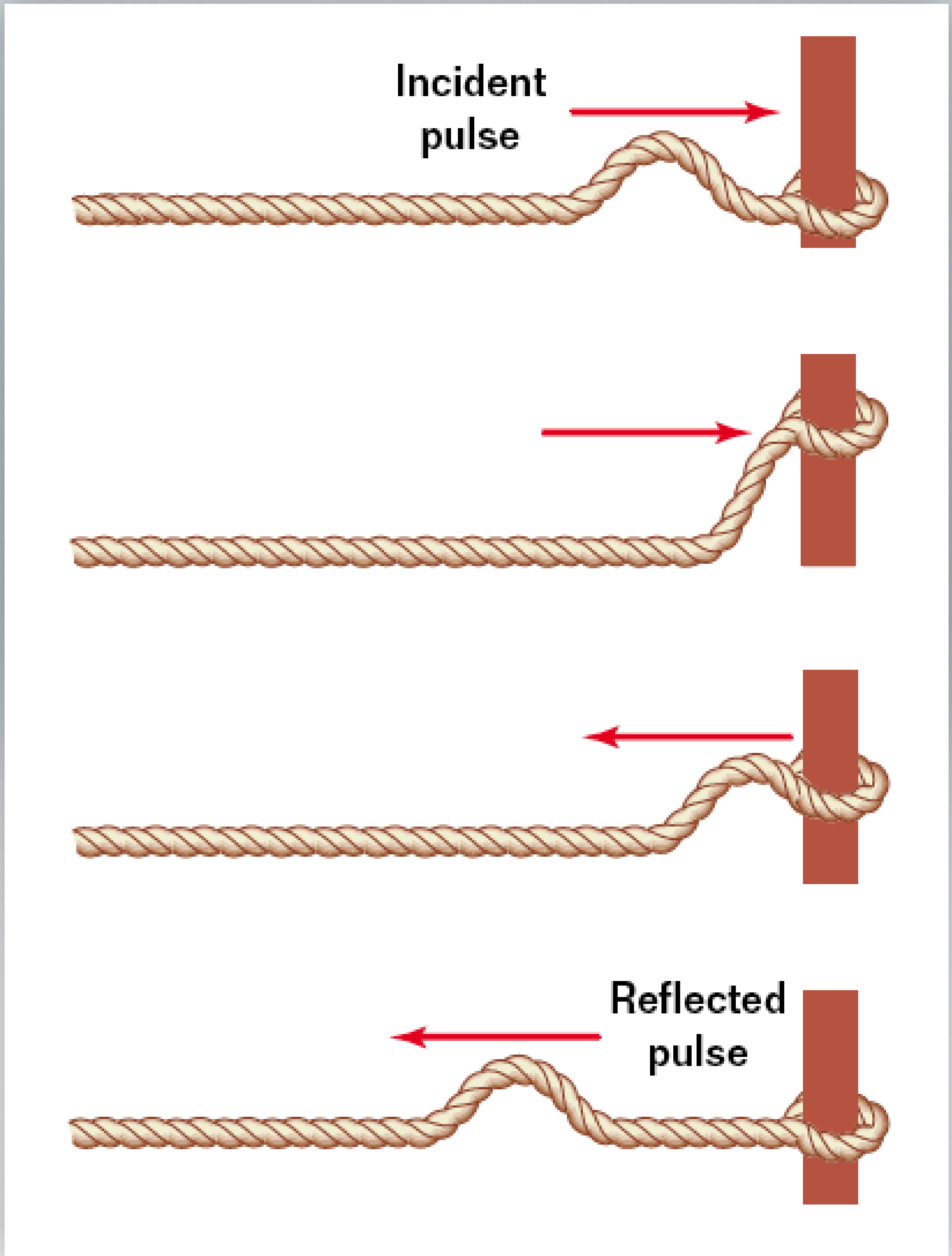
REFLECTED PULSE



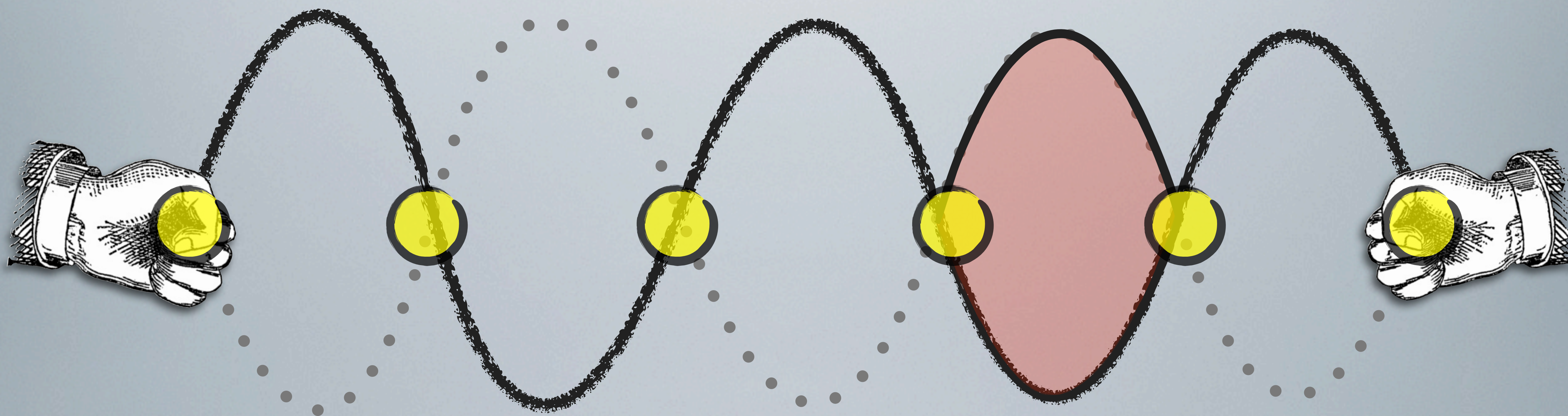
REFLECTION FROM A FIXED END



REFLECTION AT A FREE BARRIER

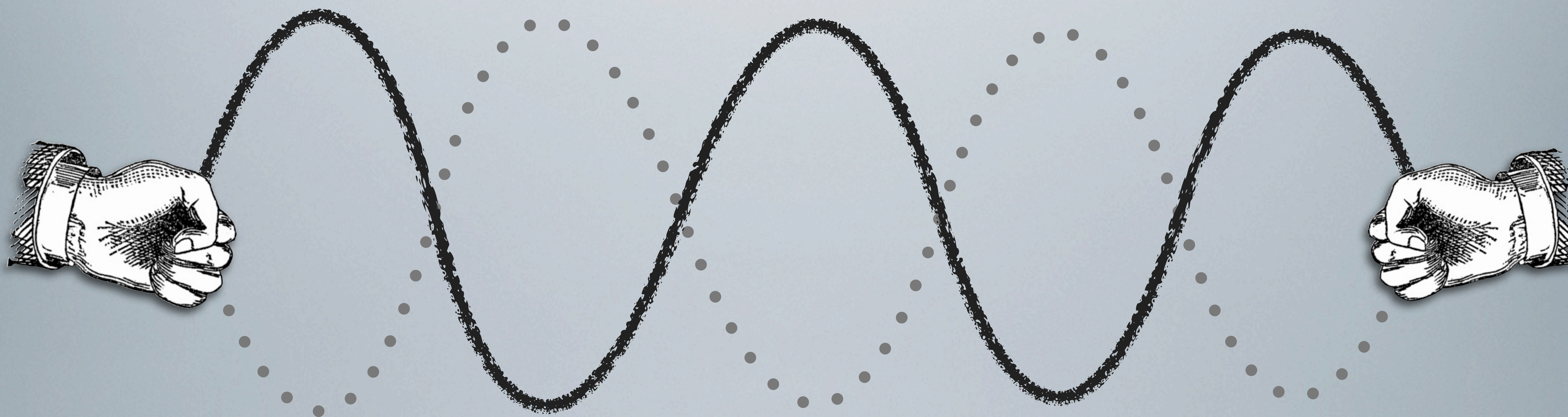


NODES / ANTINODES



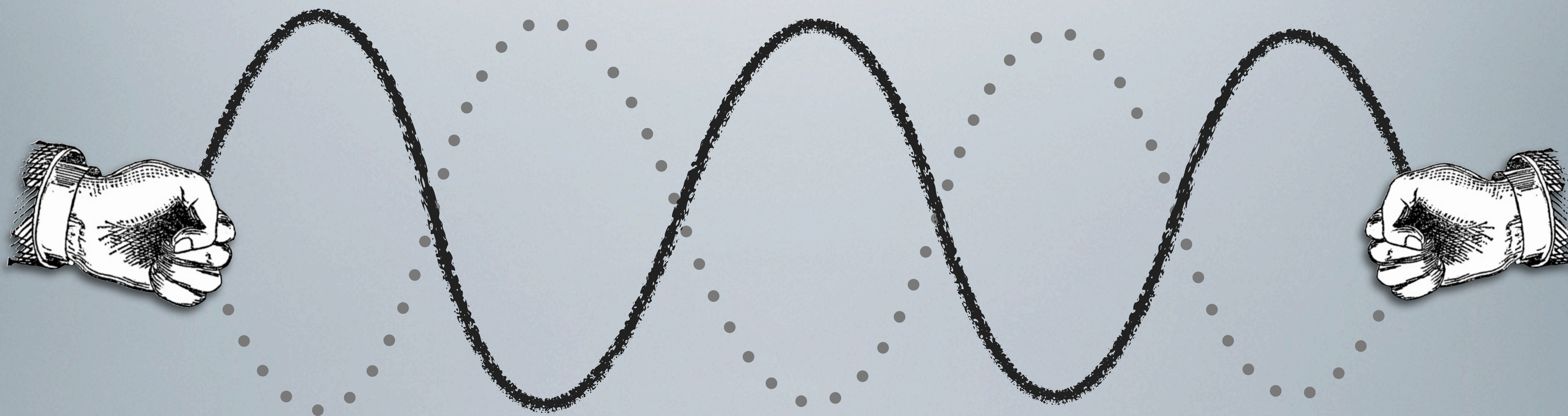
- Nodes - locations in a standing wave with **zero** displacement
- Antinodes - locations in a standing wave with **maximum** displacement

PERIOD



- Period - the time required for each cycle of motion.

FREQUENCY



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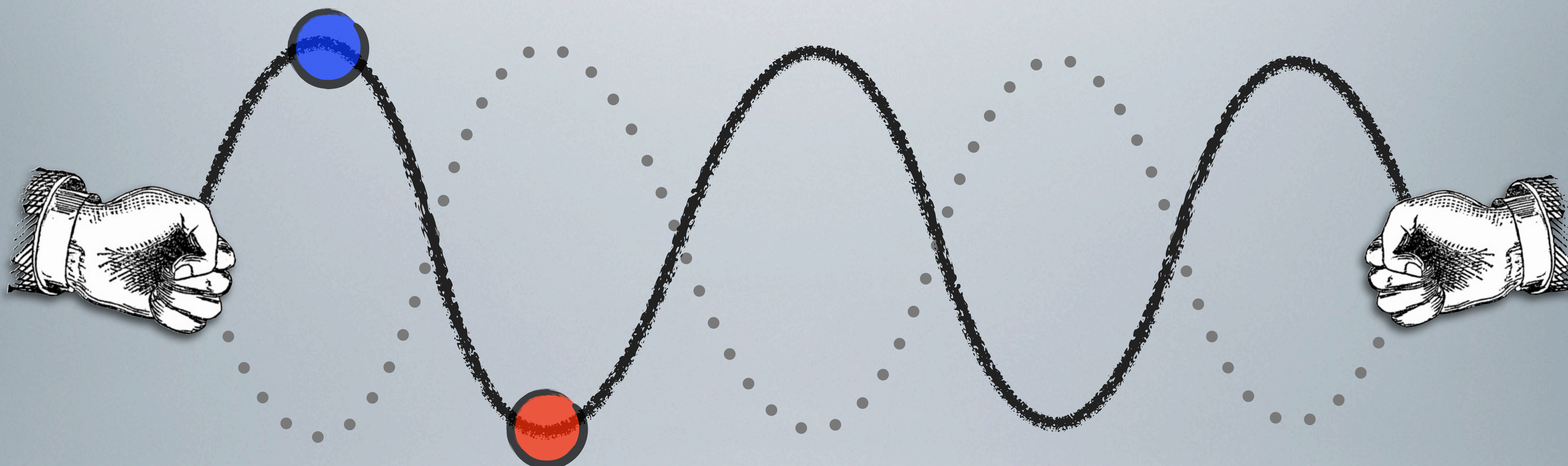
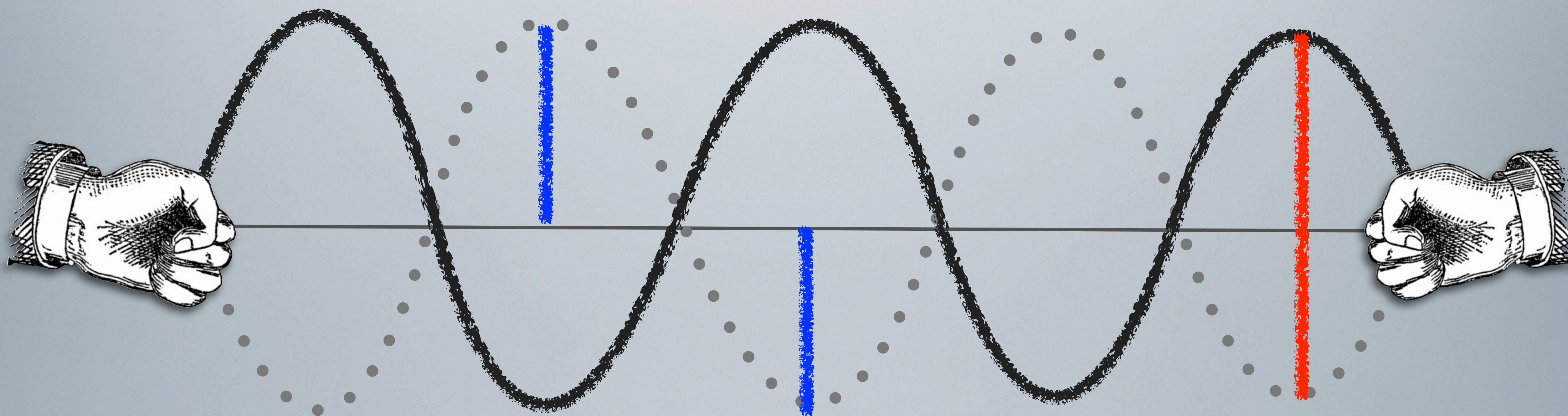
- Frequency - the number of cycles per second.
- Units - “per second”, s^{-1}, or Hertz (Hz)

CREST / TROUGH



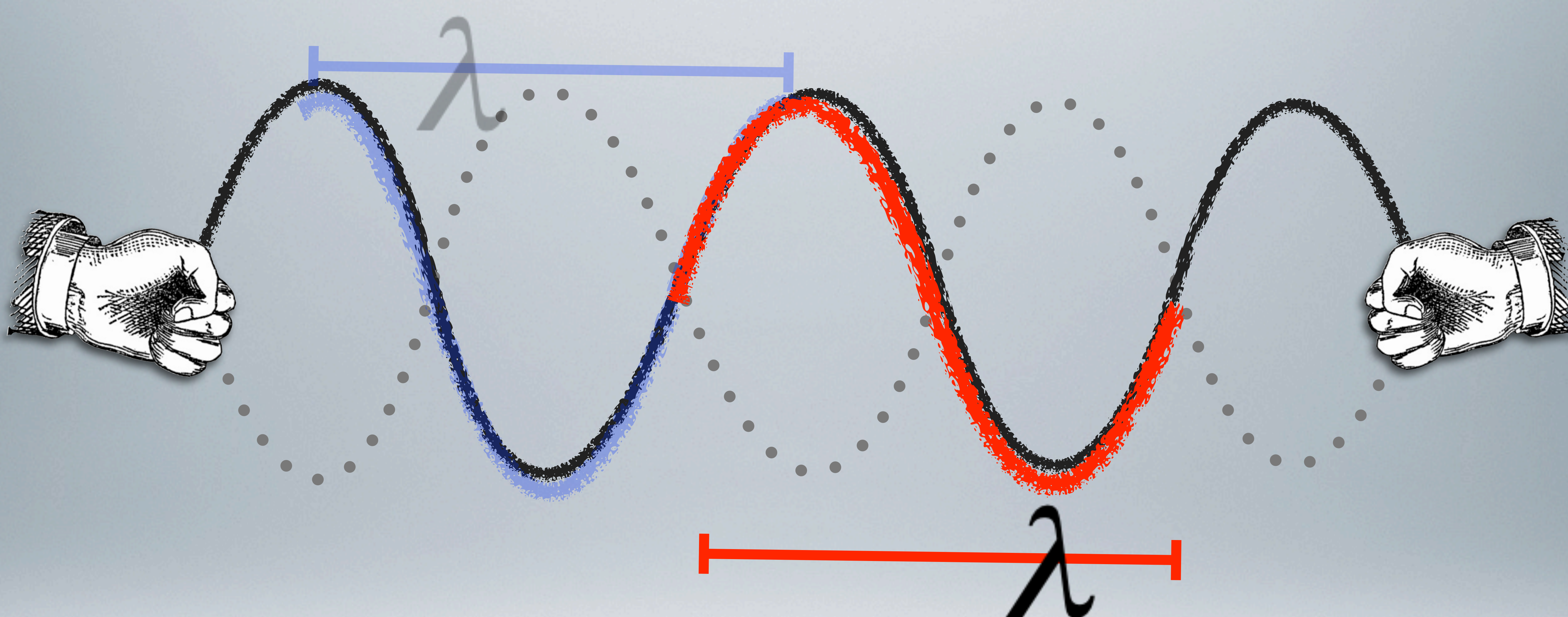
- Crest - the highest point in a wave
- Trough - the lowest point
- changes with reference point

AMPLITUDE



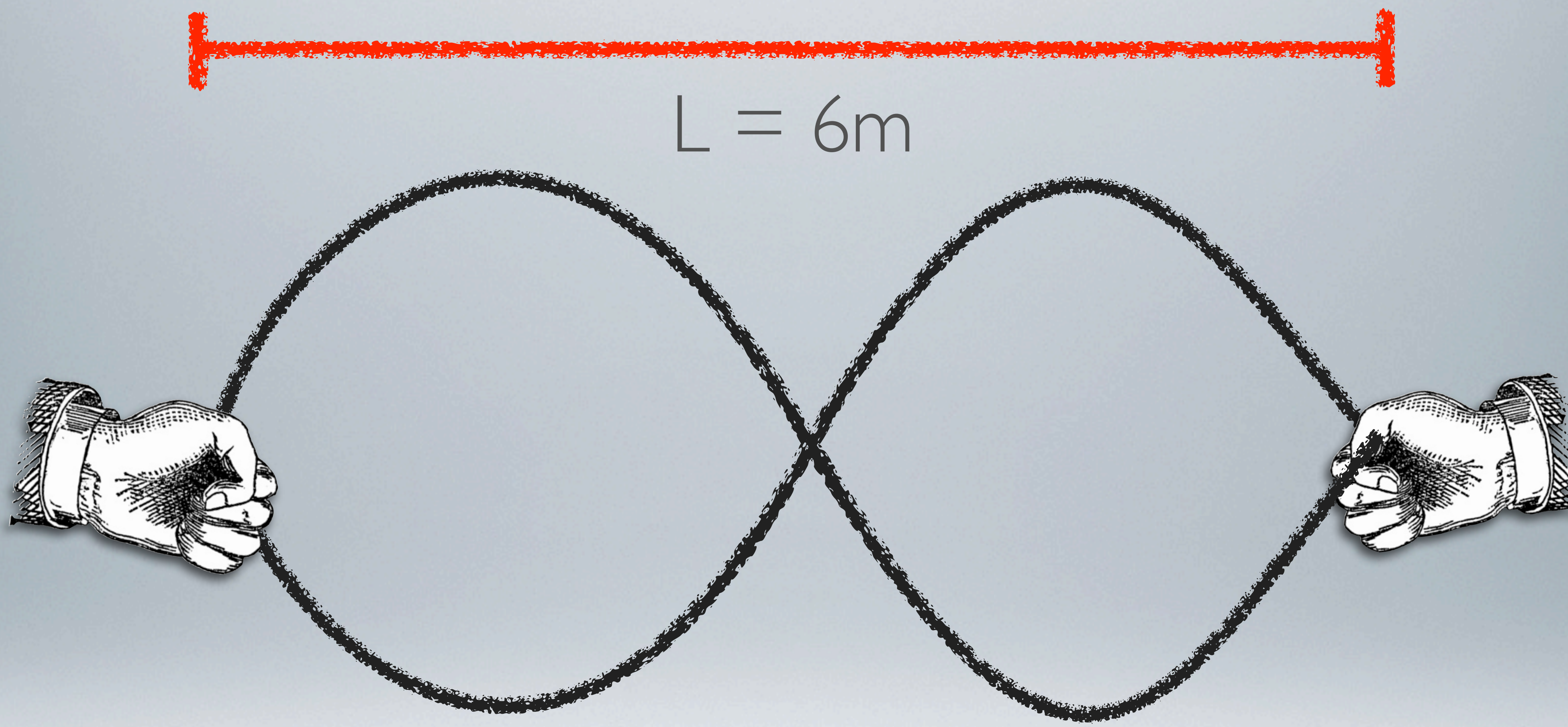
- Amplitude - The maximum displacement in a wave
- Units - m
  - some applications need the “peak to peak” amplitude

WAVELENGTH



- Wavelength - the distance (length) of a complete wave
- Units - m

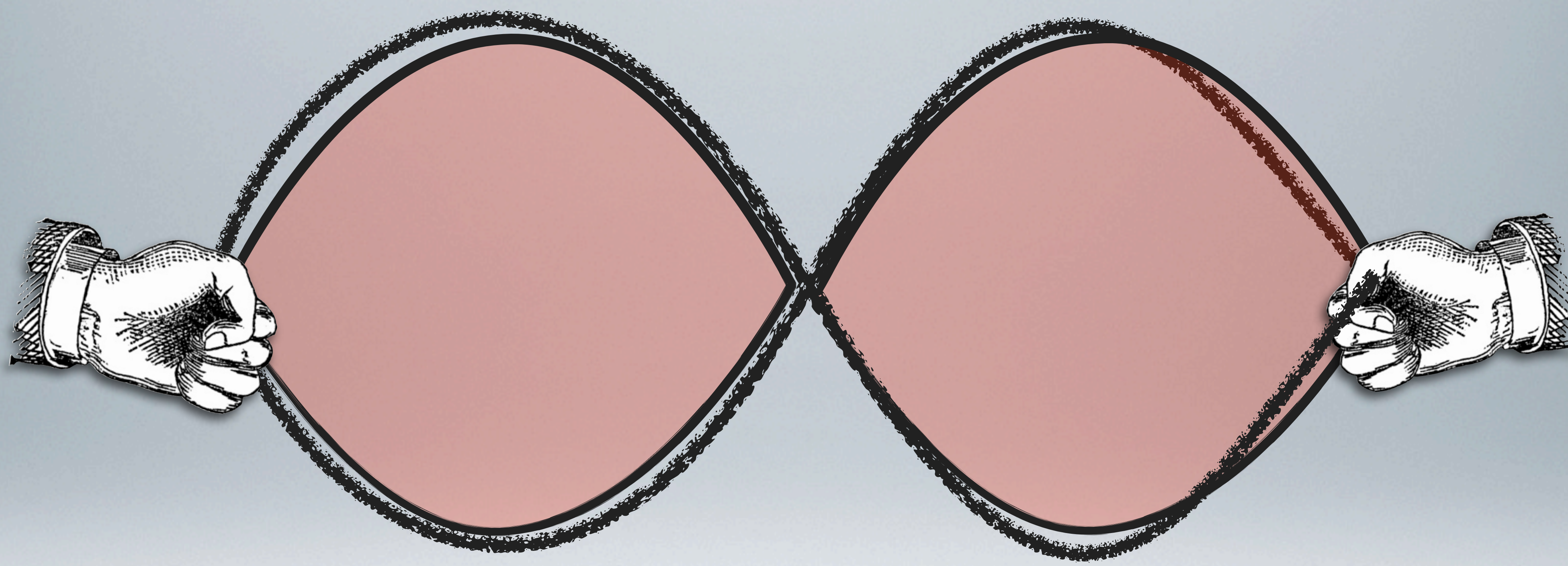
SOLVE FOR λ



$\lambda = ?$

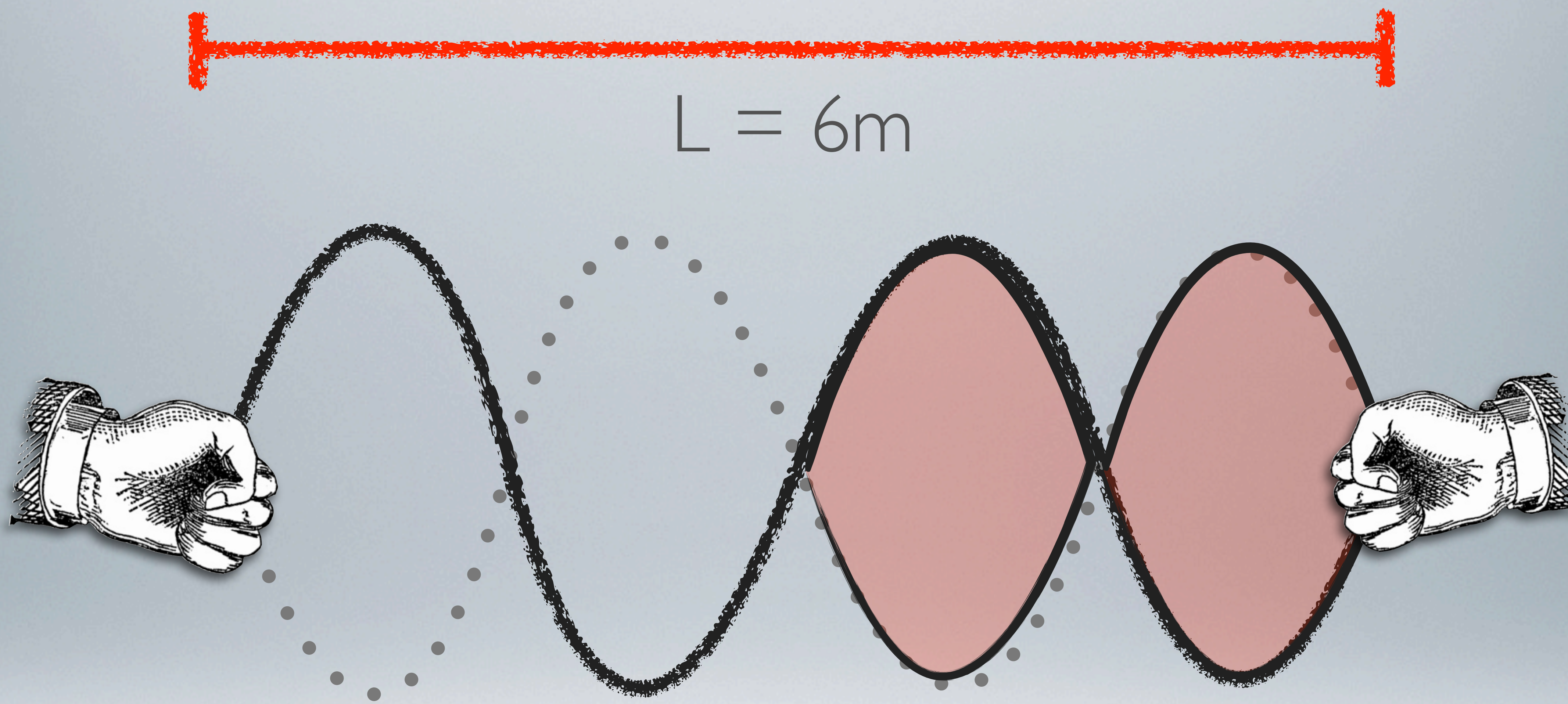
SOLVE FOR λ

L = 6m



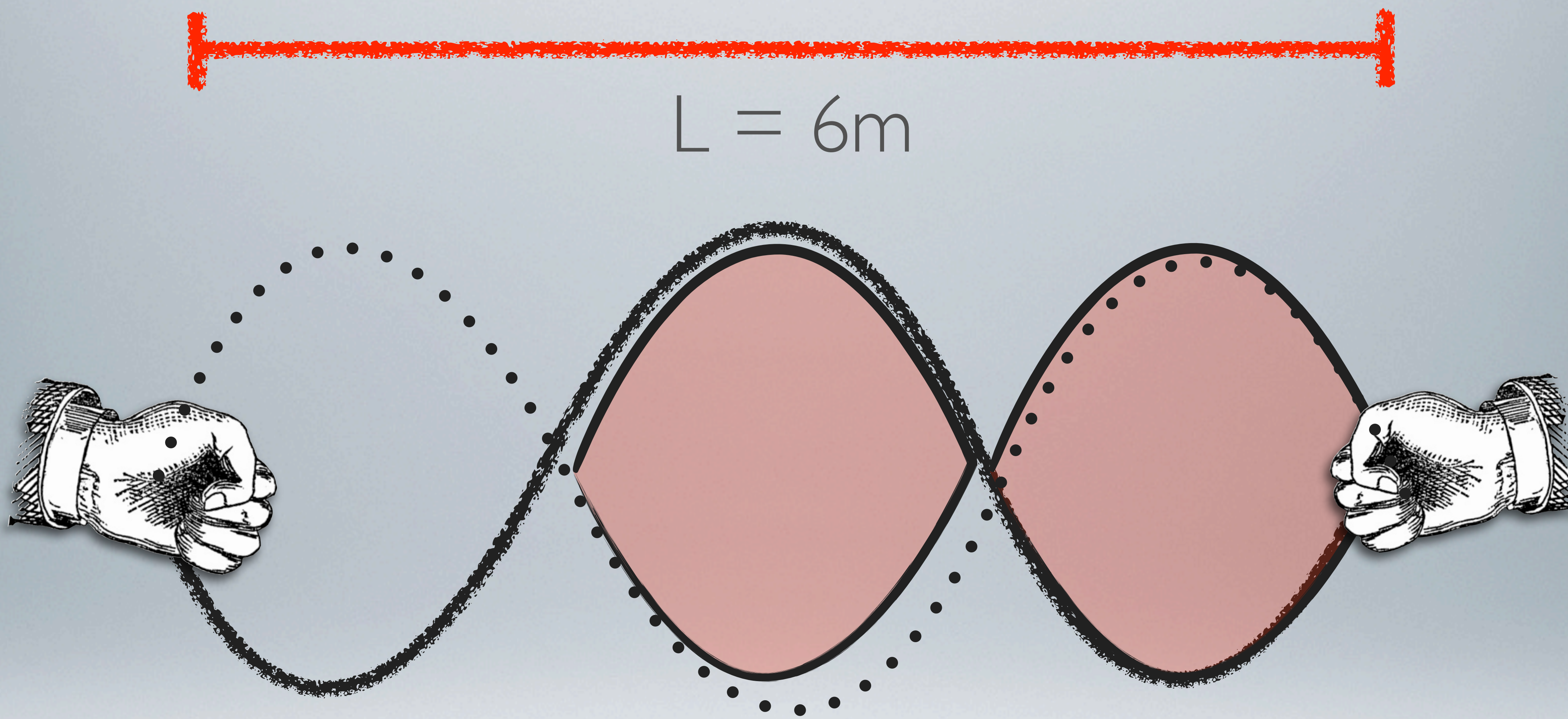
$\lambda = ?$

SOLVE FOR λ



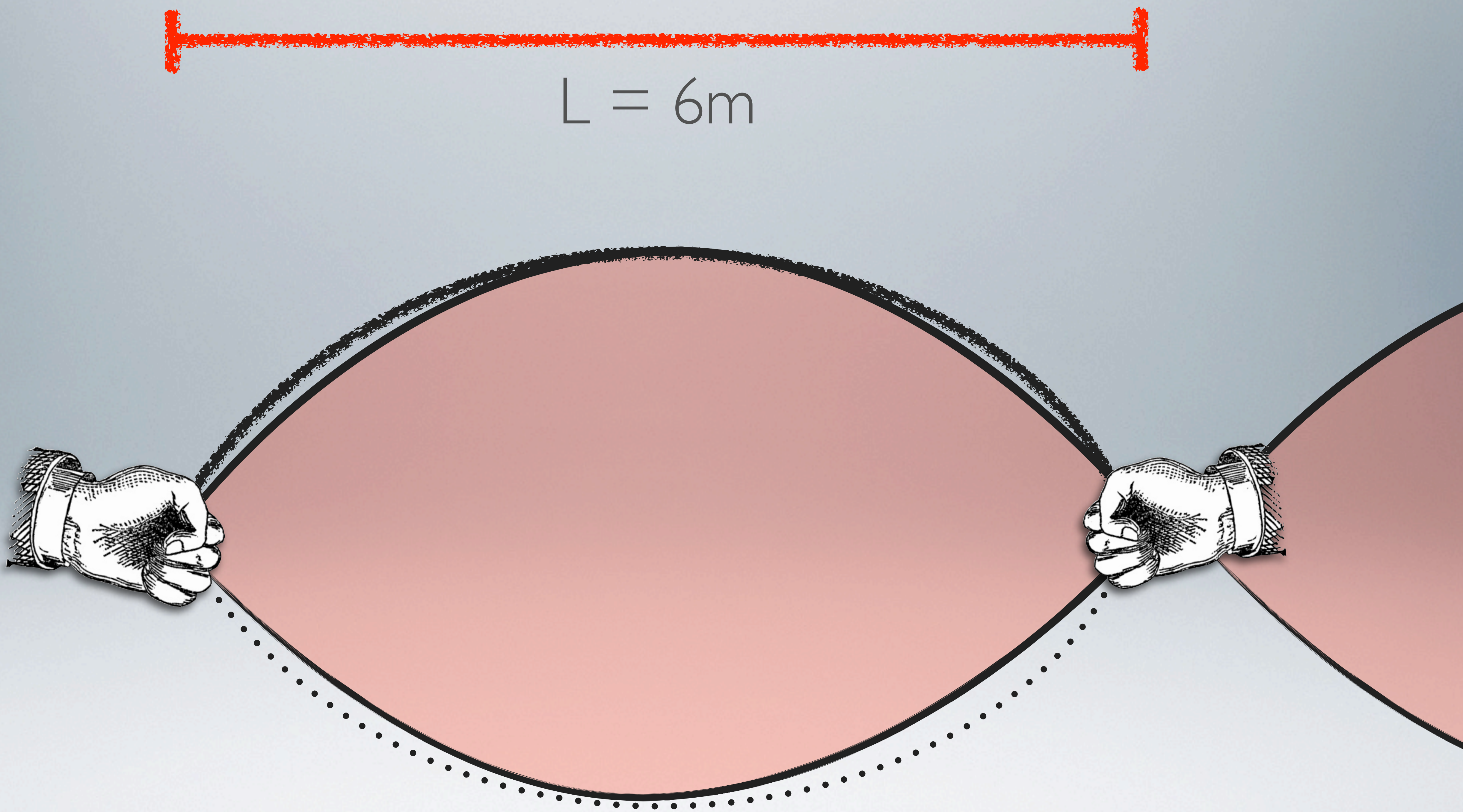
$\lambda = ?$

SOLVE FOR λ



$\lambda = ?$

SOLVE FOR λ



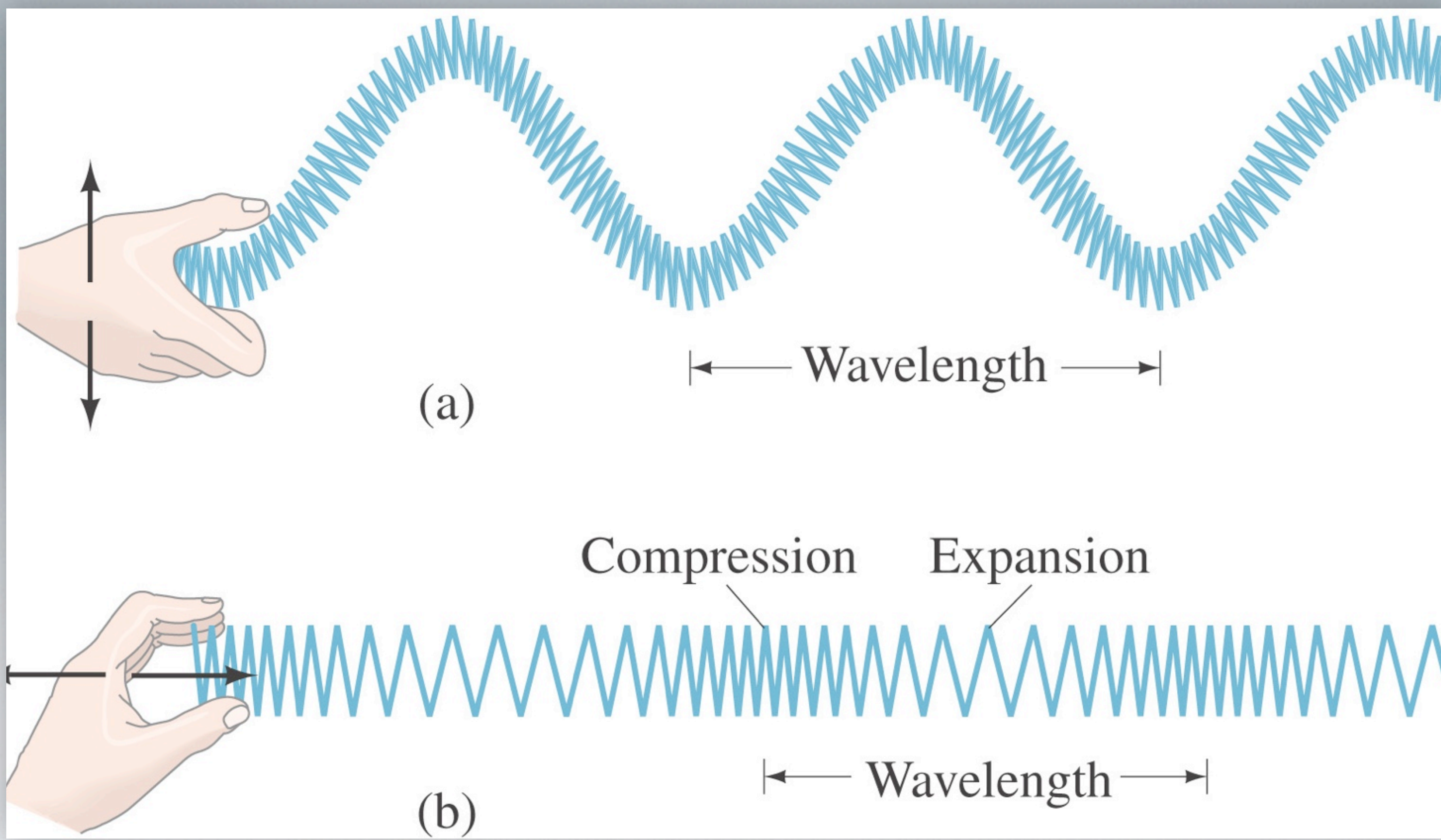
$\lambda = ?$

WAVE SPEED OR VELOCITY

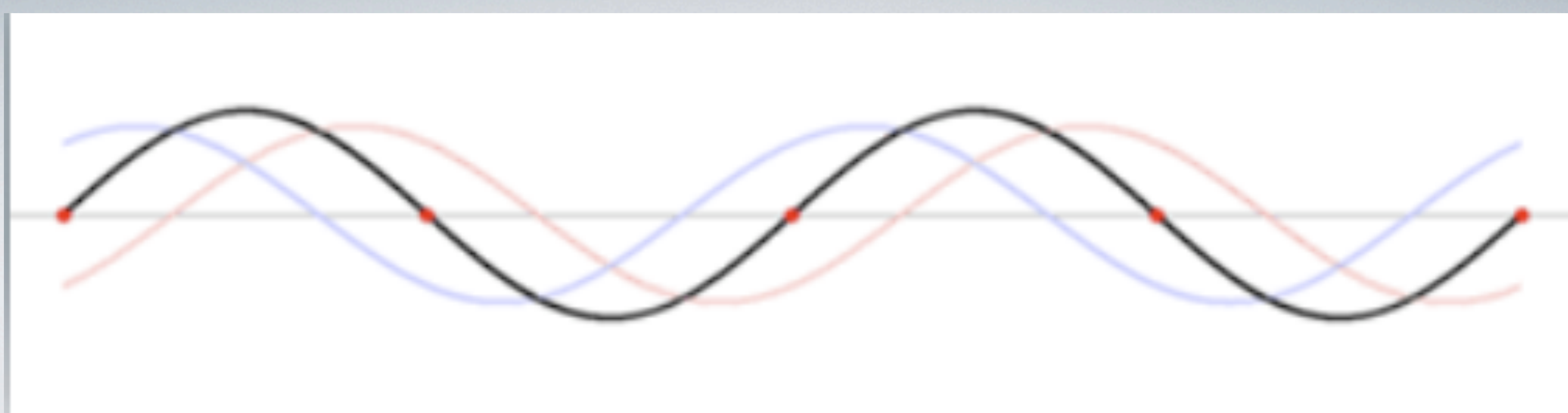
$$v = f\lambda$$

- Velocity - as it was before m/s
- frequency - Hz
- Wavelength - m
- Depends on the medium
- Speed of Sound in Air - 341 m/s
- Speed of Light in a Vacuum - 3.0×10^8 m/s

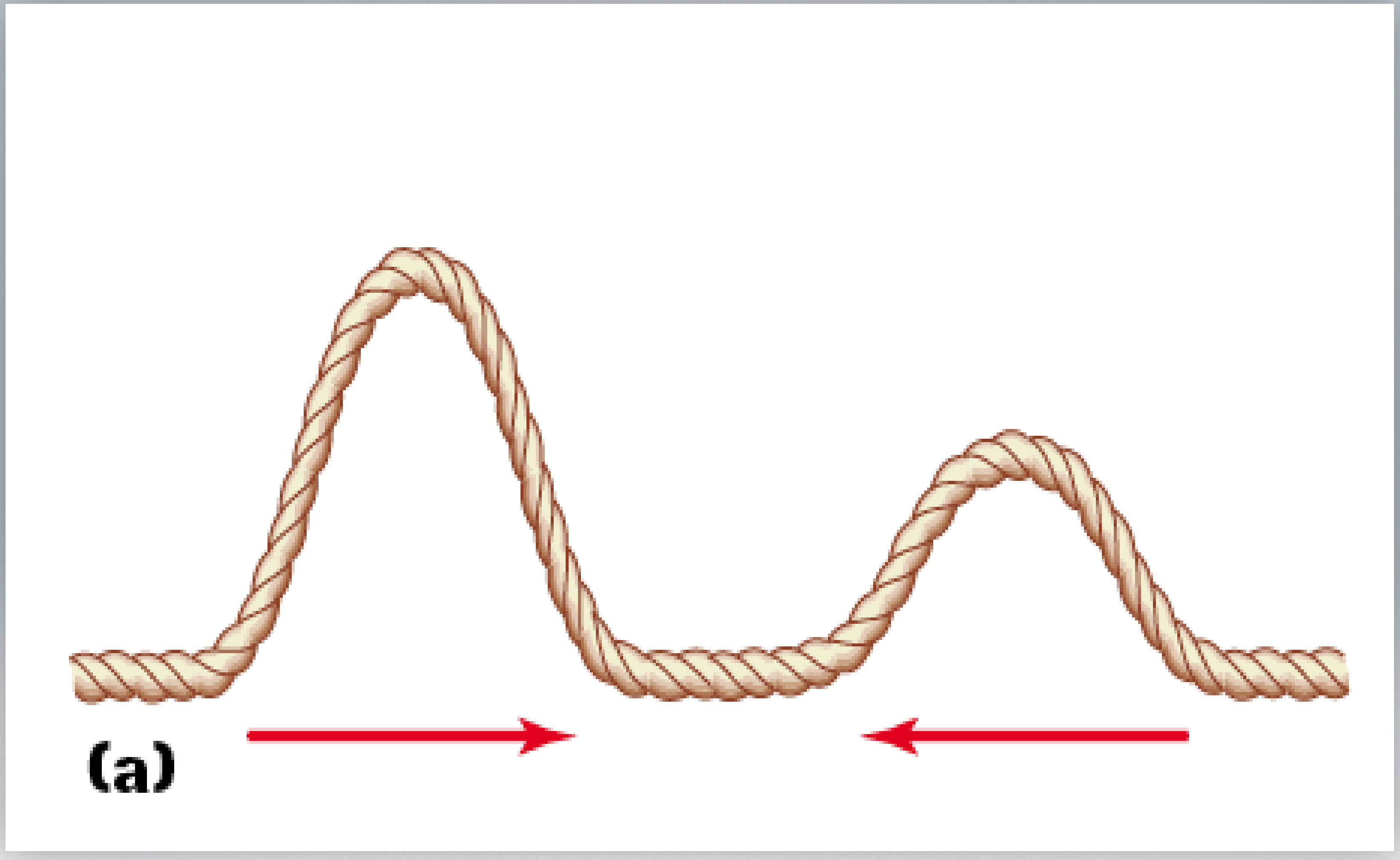
TRANSVERSE AND LONGITUDINAL WAVES



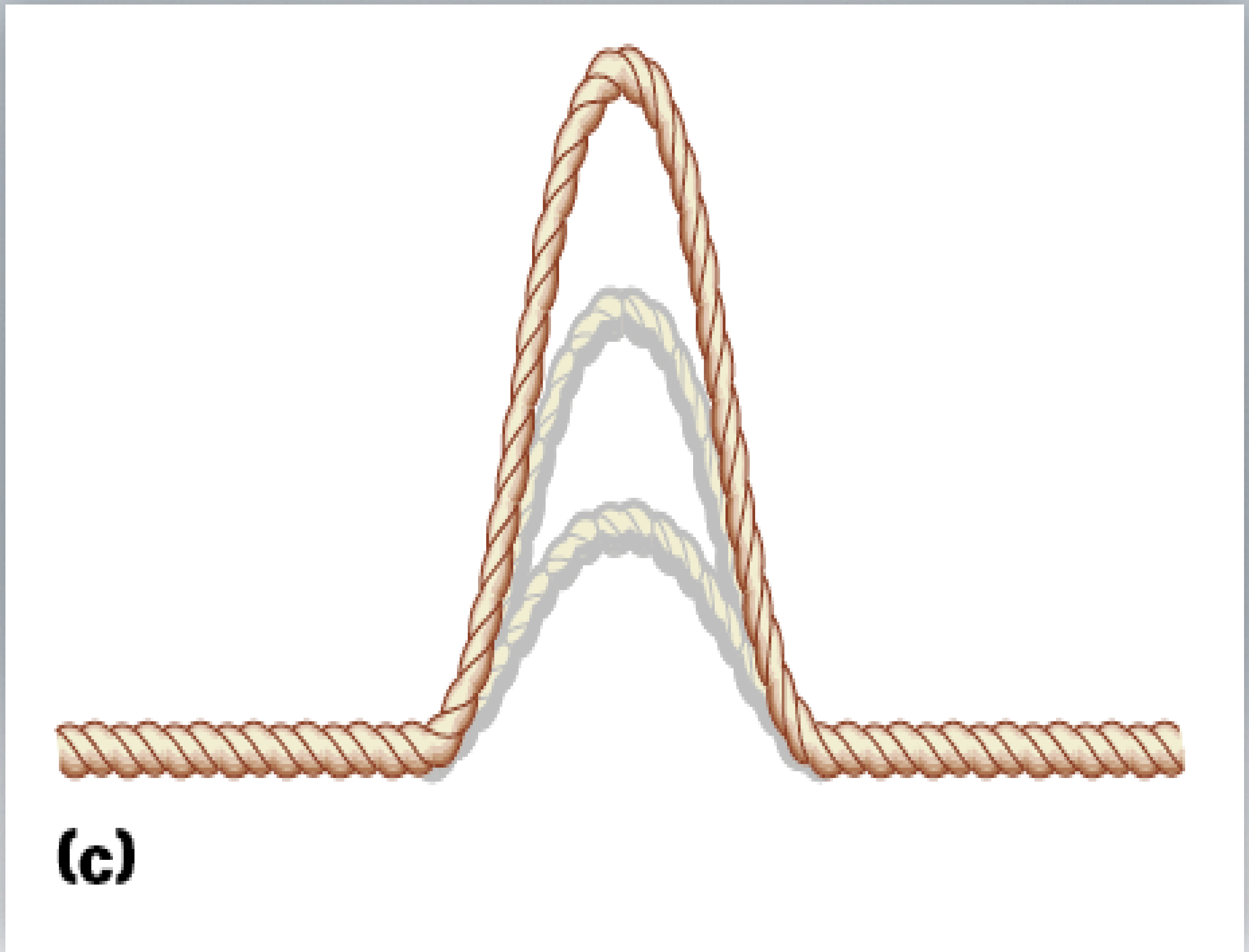
WHY DID YOU SEE NODES?



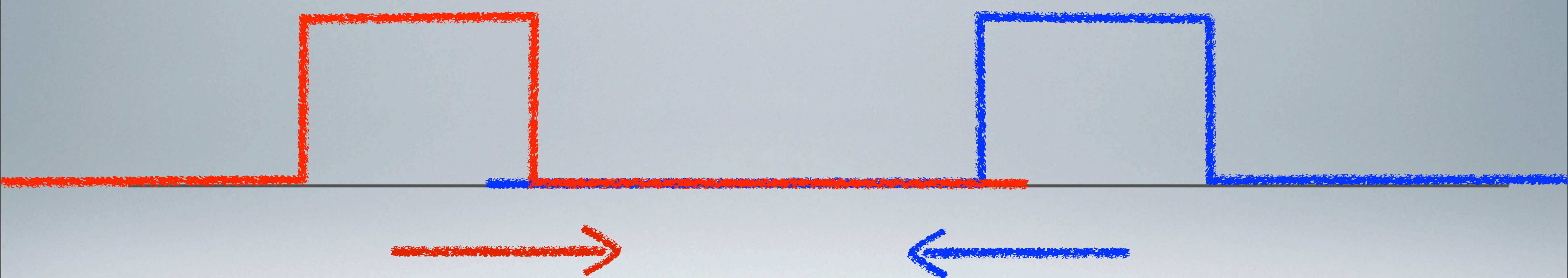
PRINCIPLE OF SUPERPOSITION



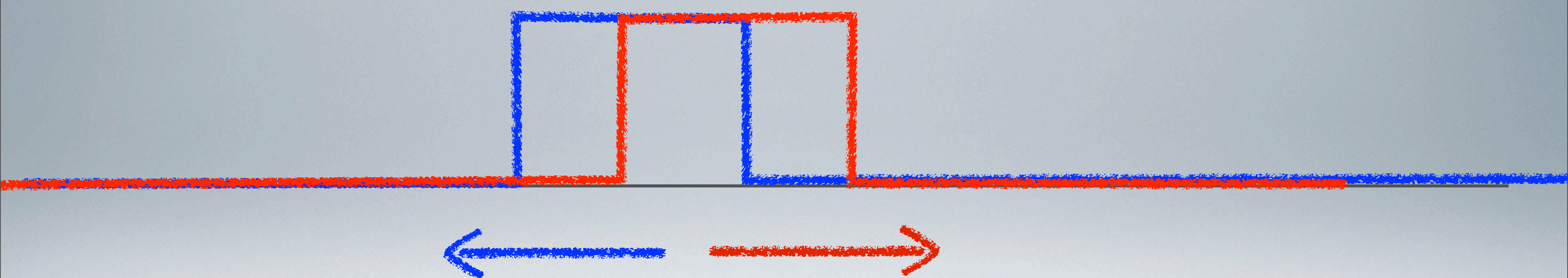
THE EASIEST CASE



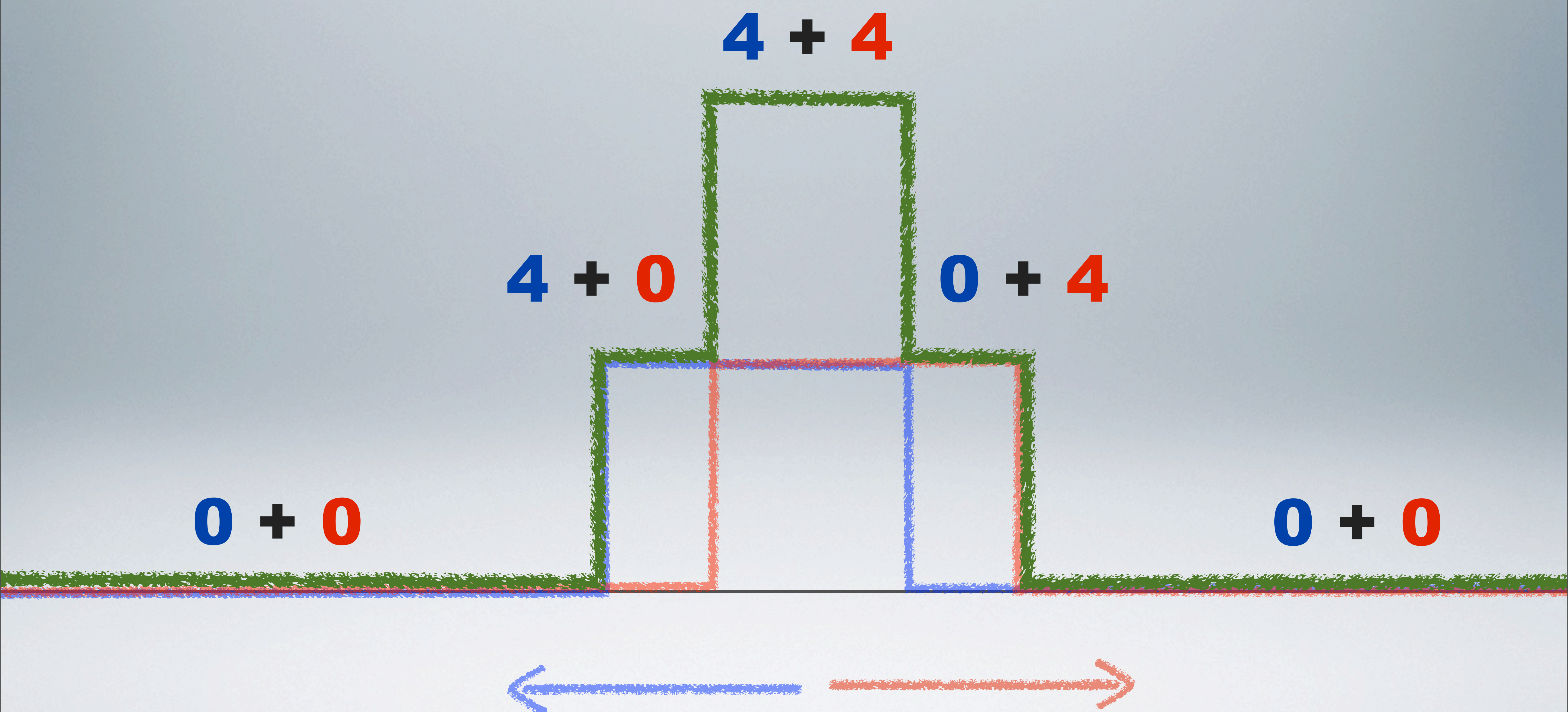
EASY CASE



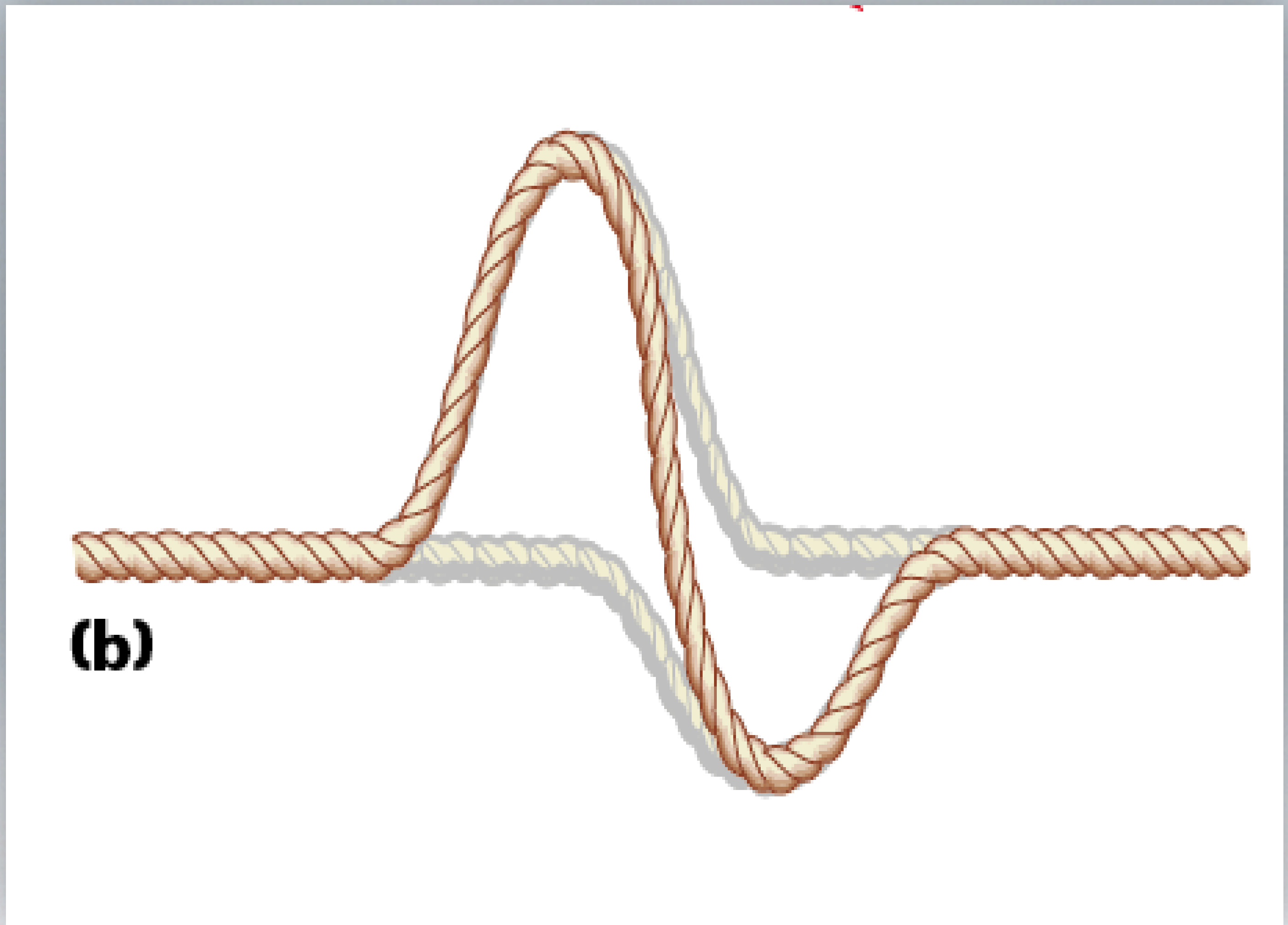
EASY CASE



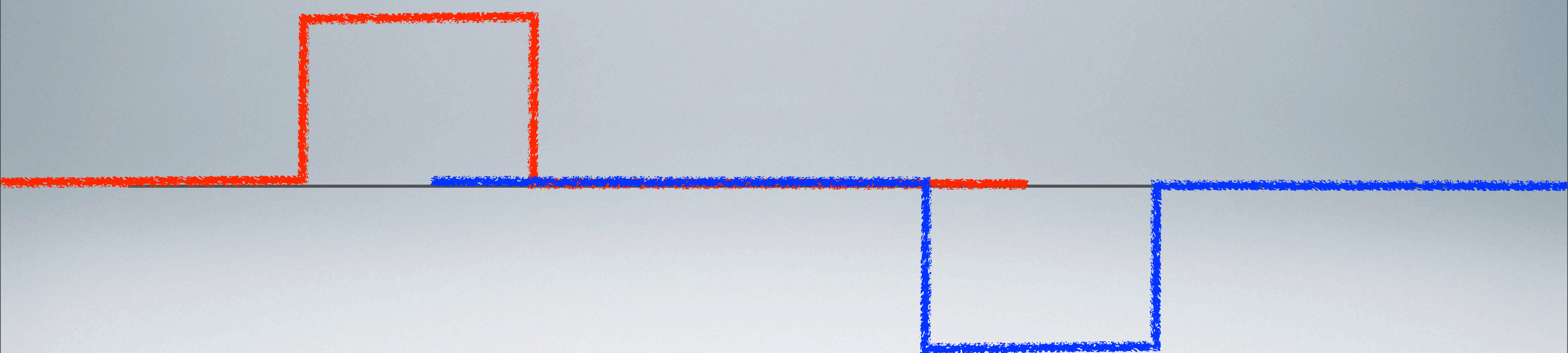
EASY CASE



EVEN IF THEY'RE NEGATIVE



STILL PRETTY EASY CASE



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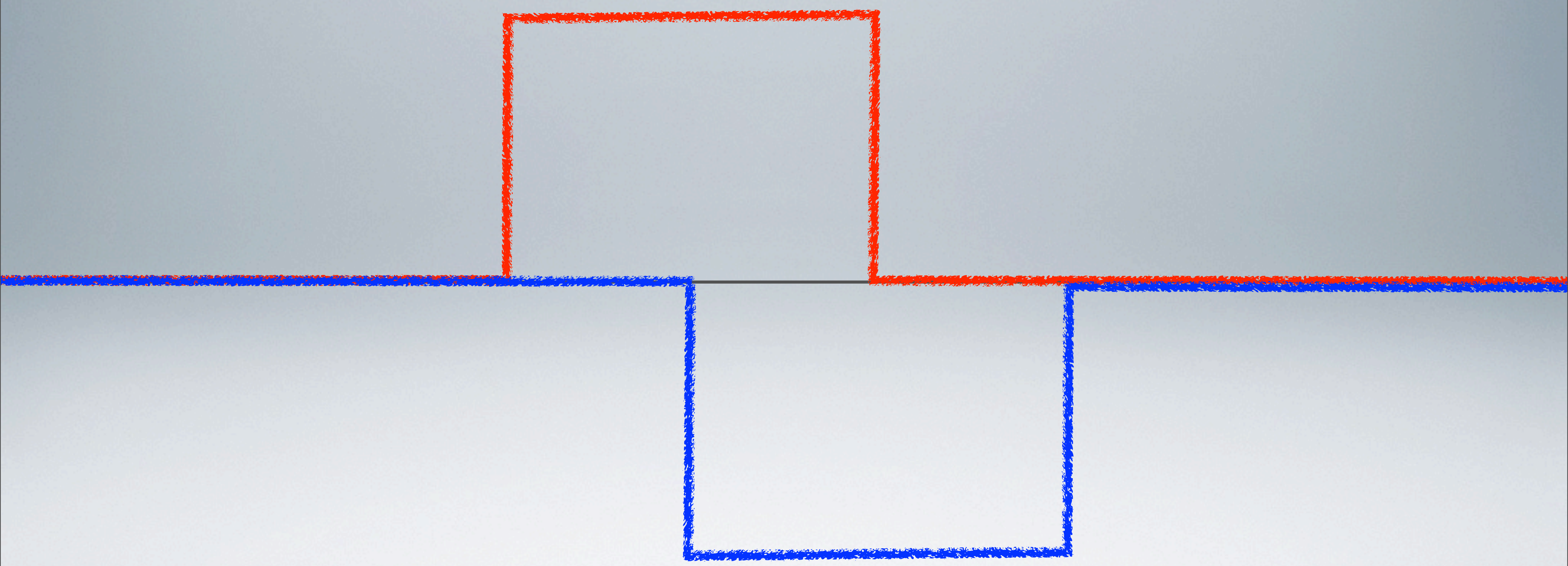
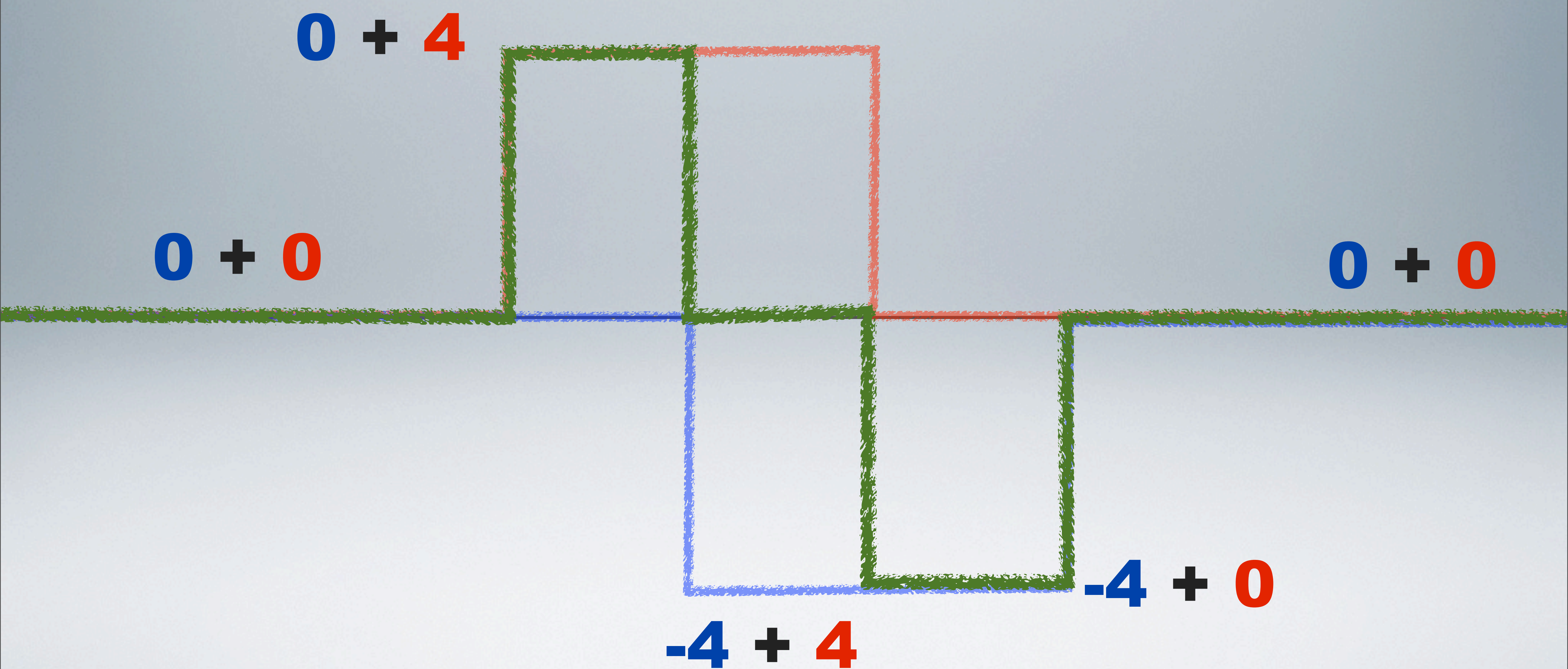
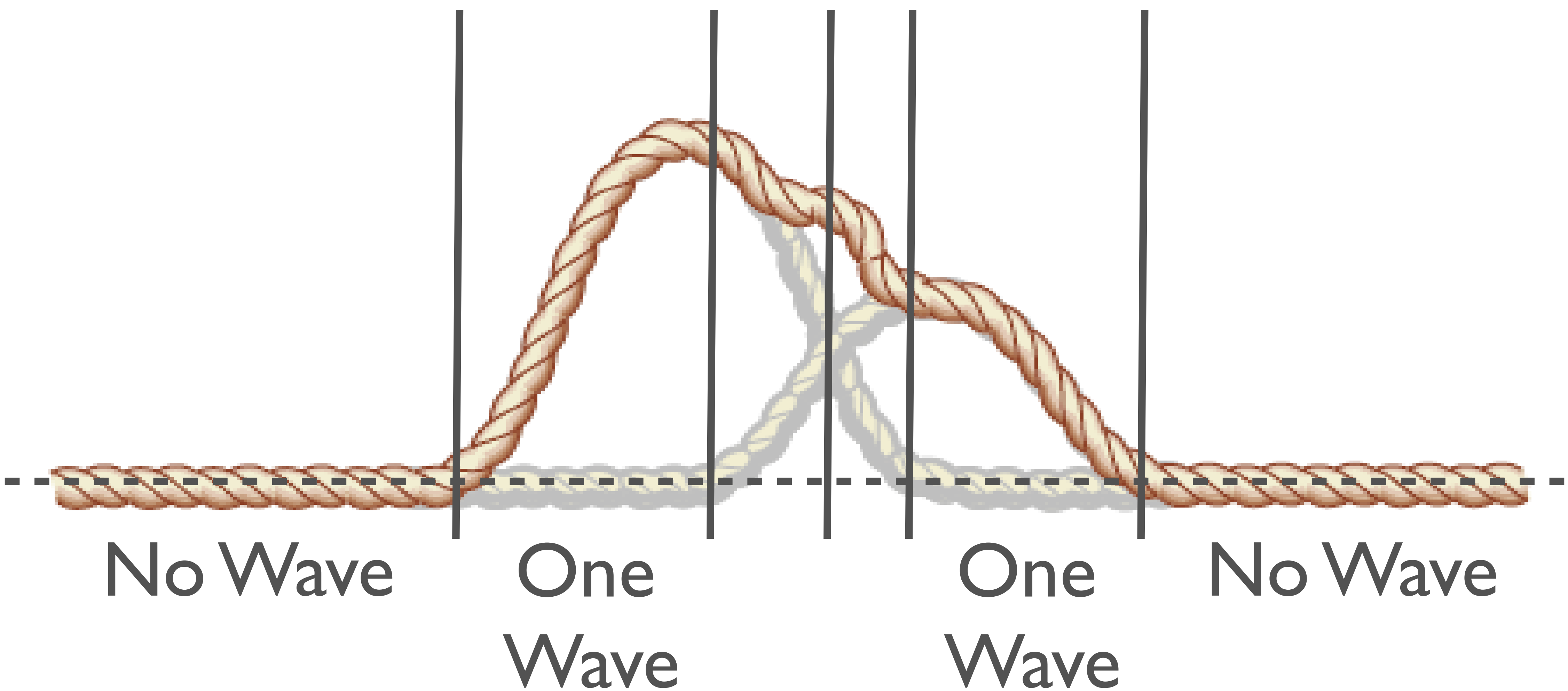


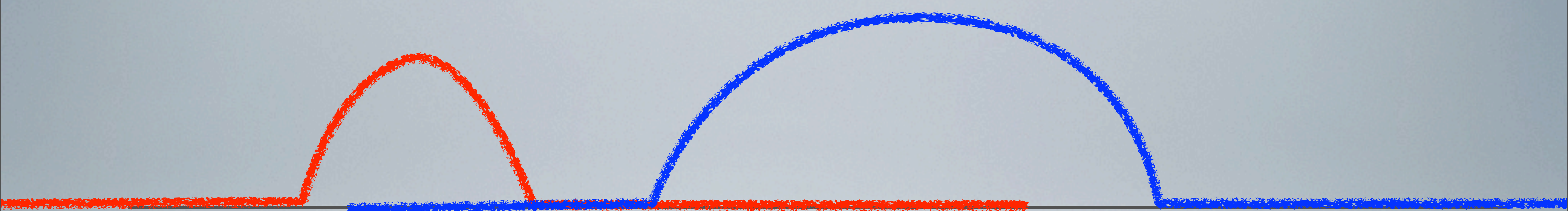
STILL PRETTY EASY CASE



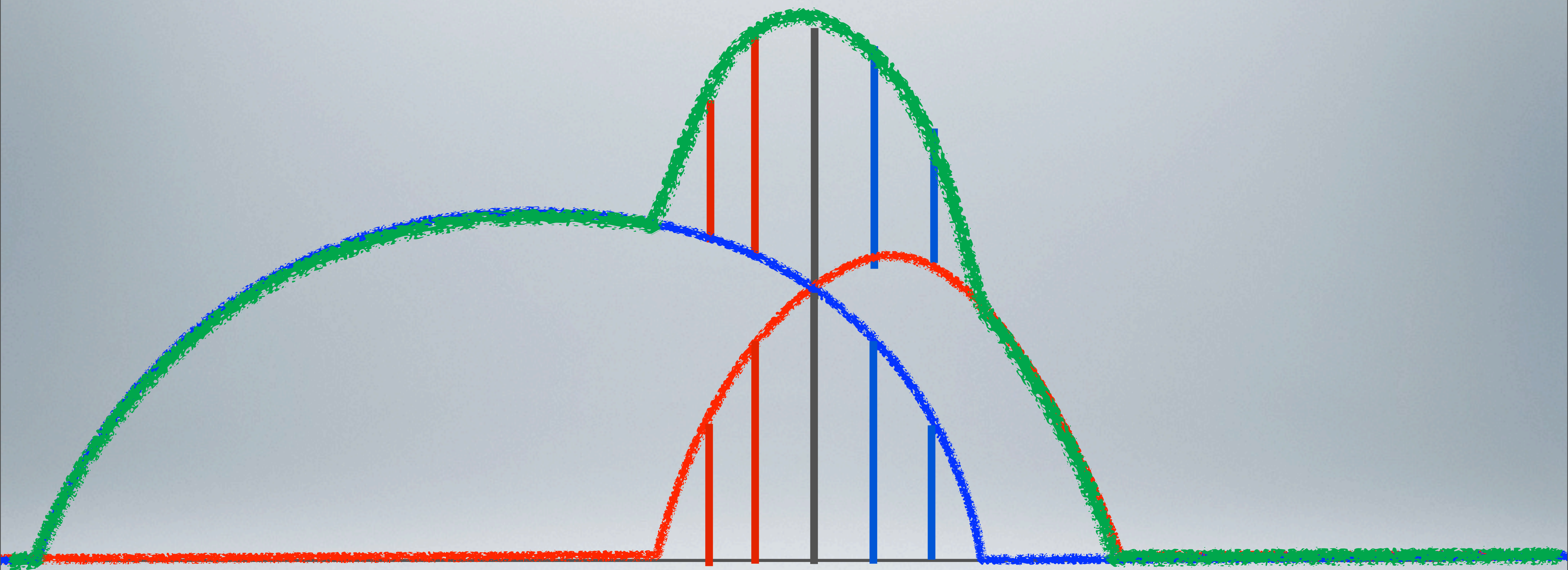
ADD ALL THE HEIGHTS



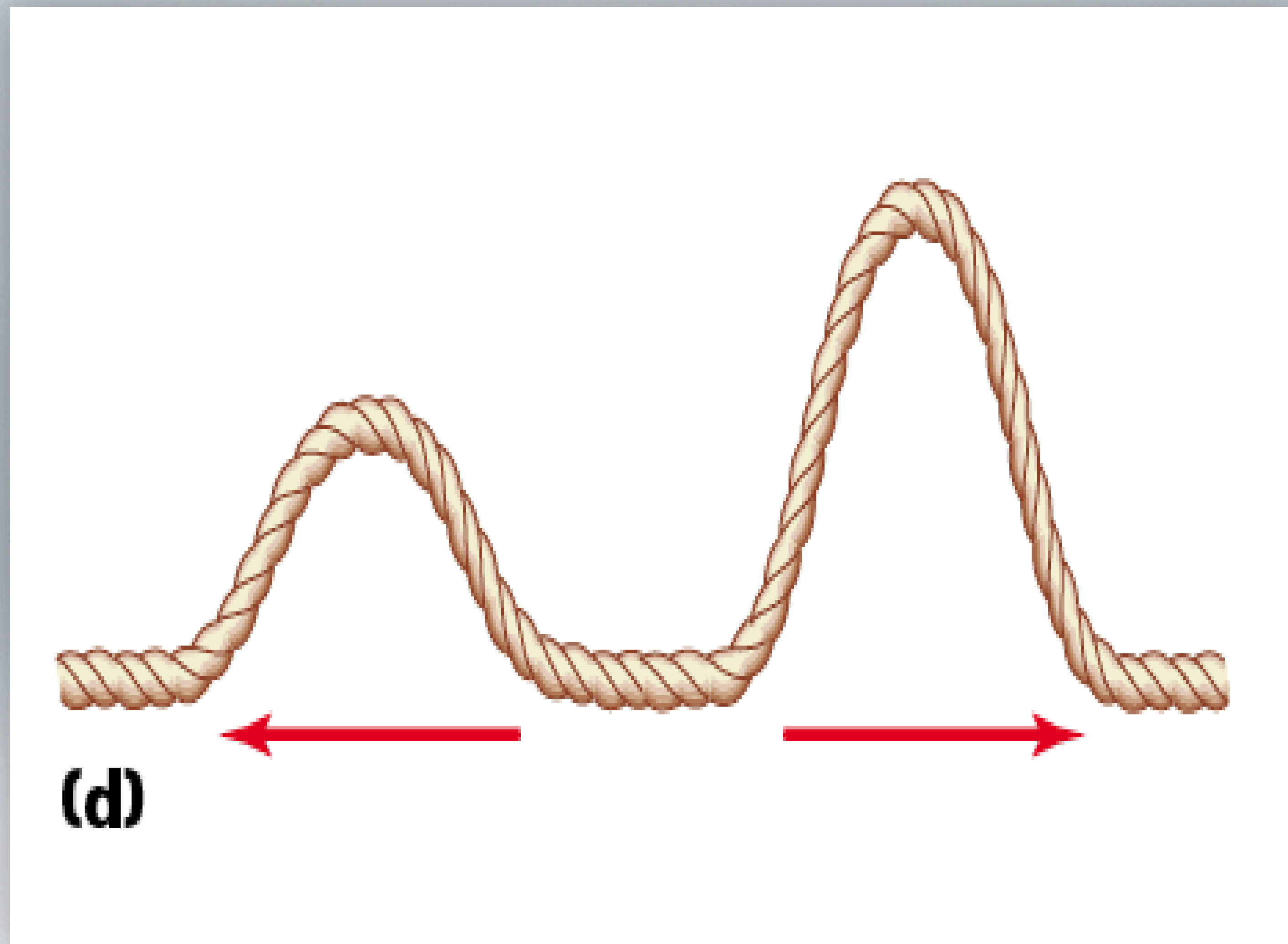
MORE REAL



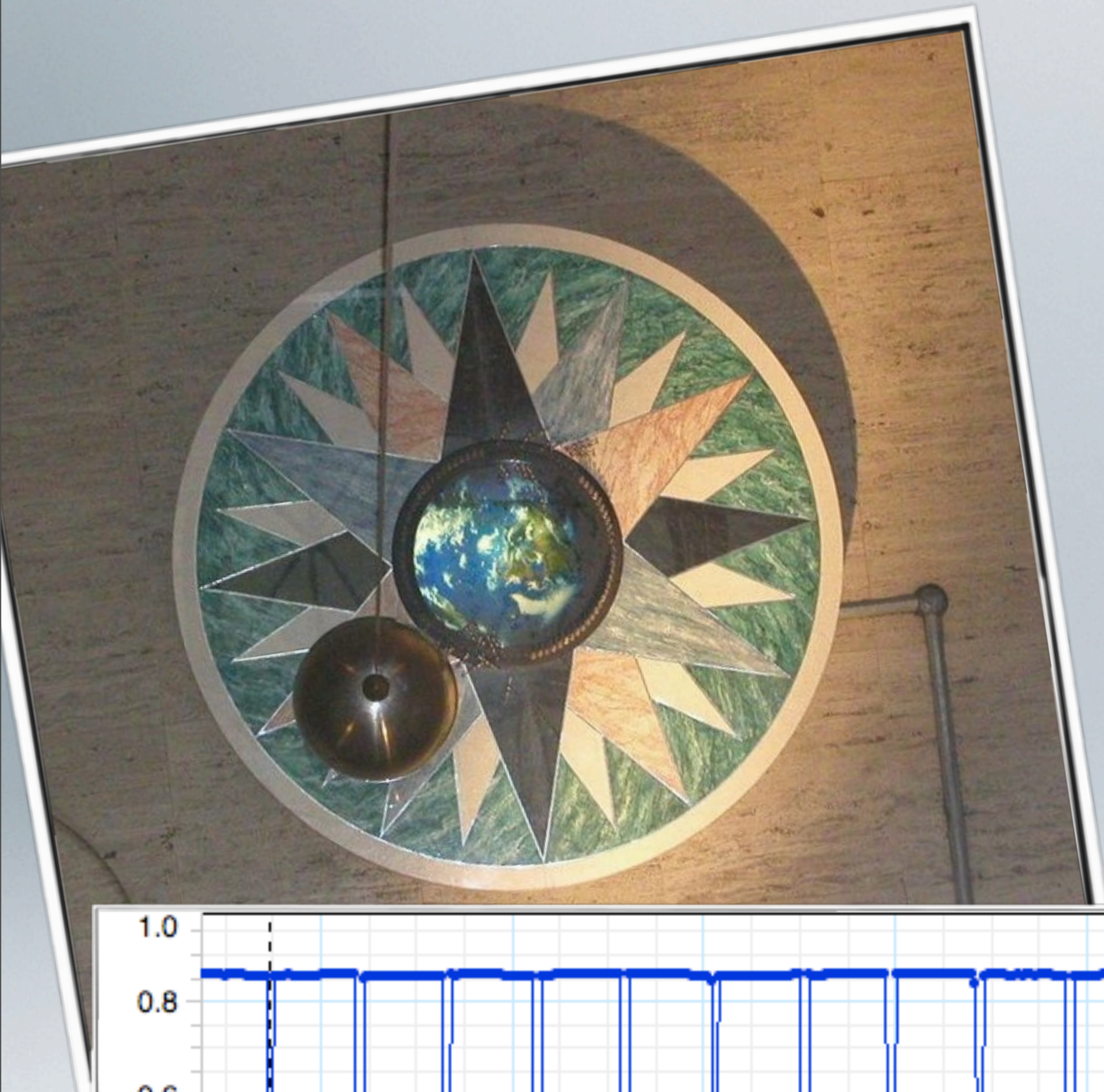
MORE REAL



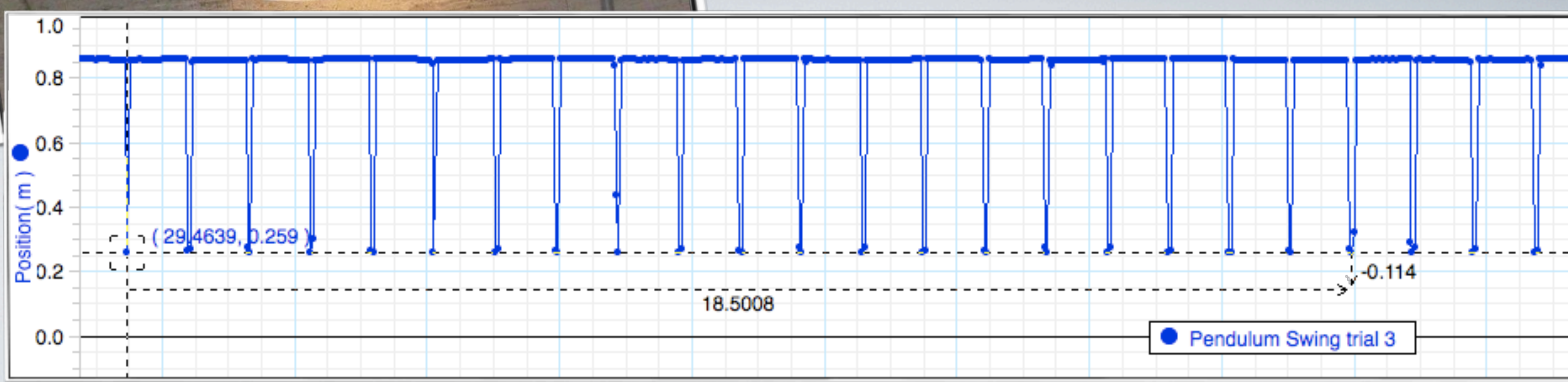
WHAT HAPPENS AFTERWARDS



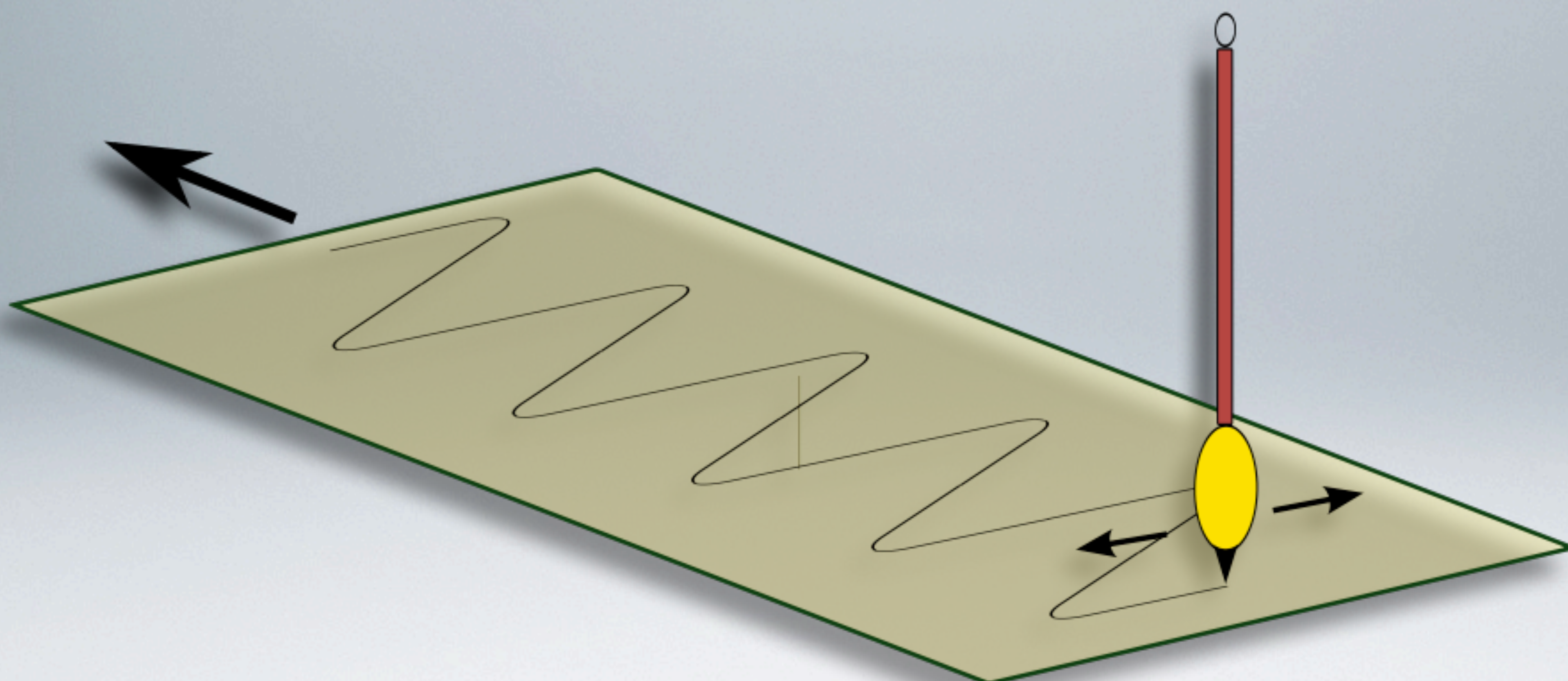
PENDULUM LAB



$$T = 2\pi\sqrt{\frac{l}{g}}$$

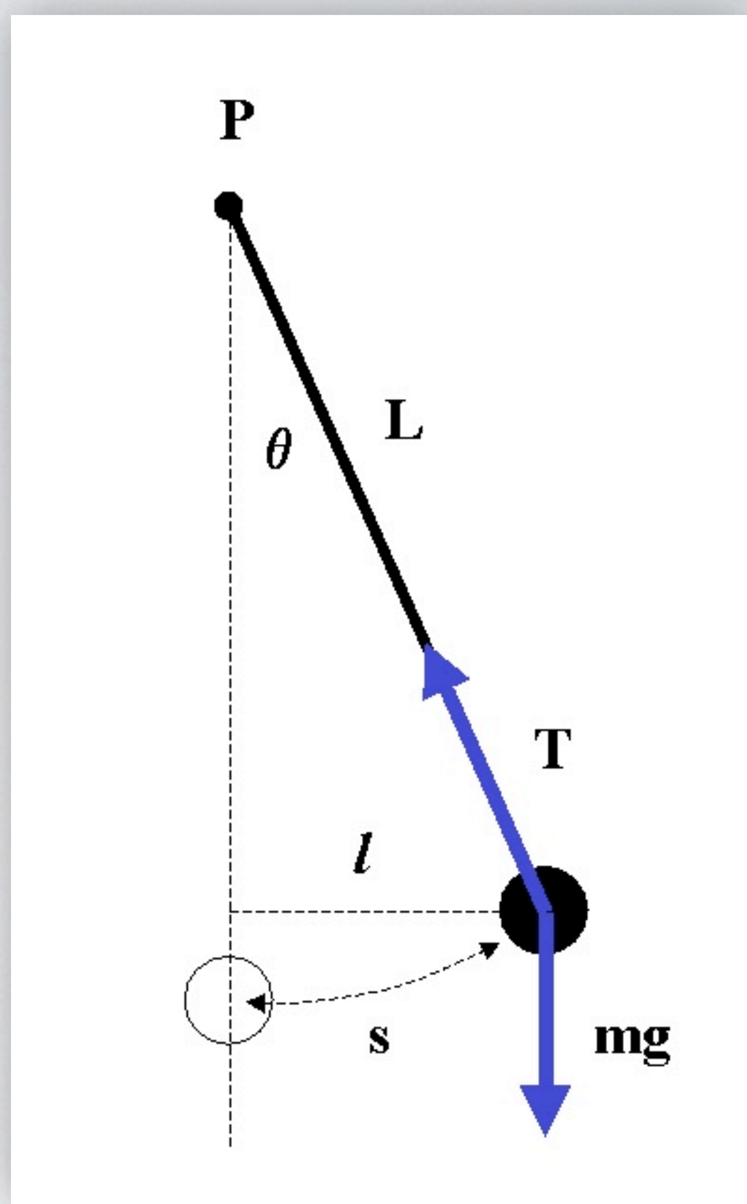


WAVE-LIKE GRAPH



THE PENDULUM

$$T = 2\pi\sqrt{l/g}$$



- An Easy Equation
- Simple Harmonic Motion

PENDULUM LENGTH

- What is the length of a pendulum that has a frequency of 0.25 Hz here on Earth?

$$T = 2\pi\sqrt{\frac{l}{g}}$$

$$4 = 2\pi\sqrt{\frac{l}{g}}$$

$$\frac{4}{2\pi} = \sqrt{\frac{l}{g}}$$

$$0.64 = \sqrt{\frac{l}{g}}$$

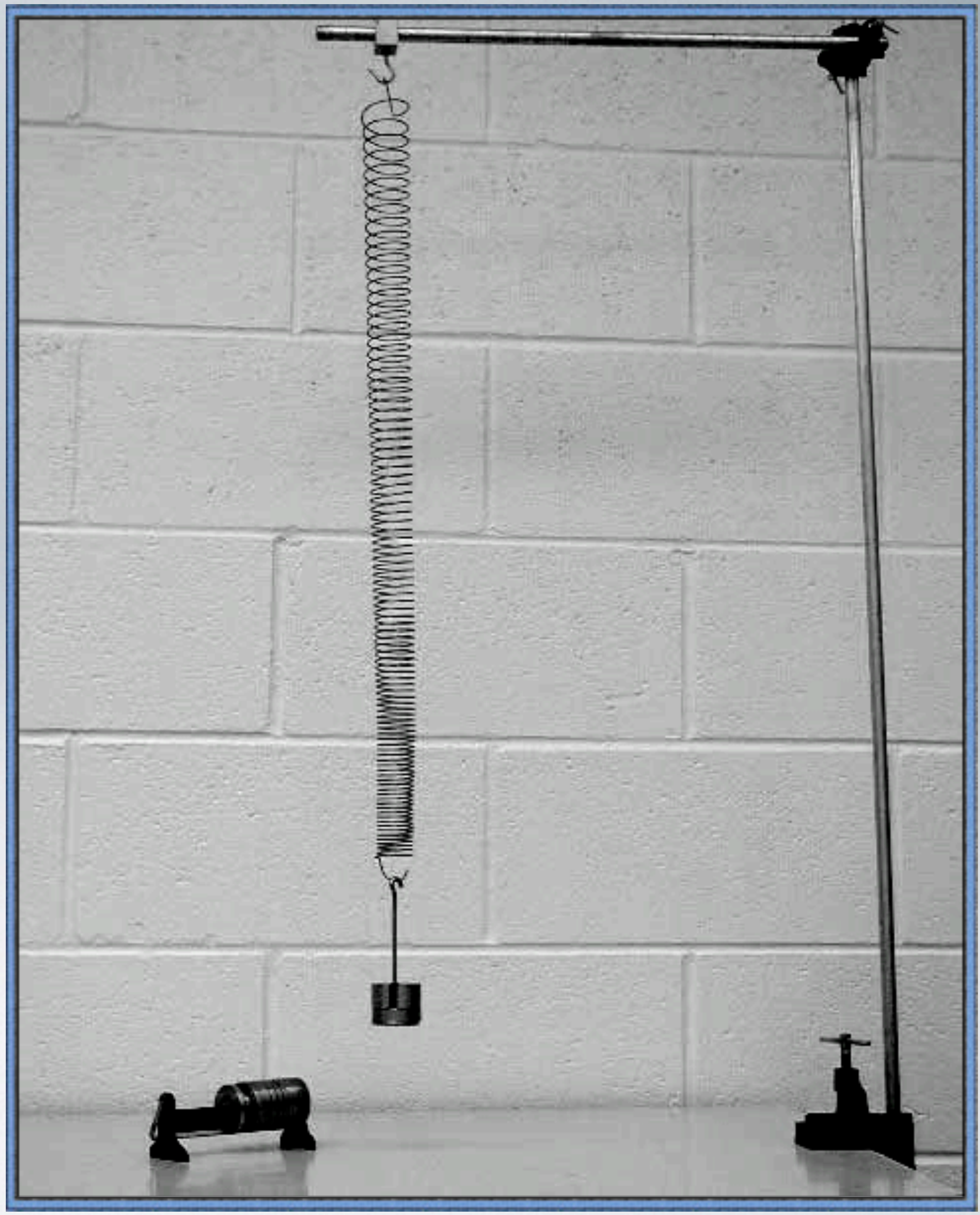
$$0.406 = \frac{l}{9.8}$$

$$3.97m = l$$

MASS ON A SPRING

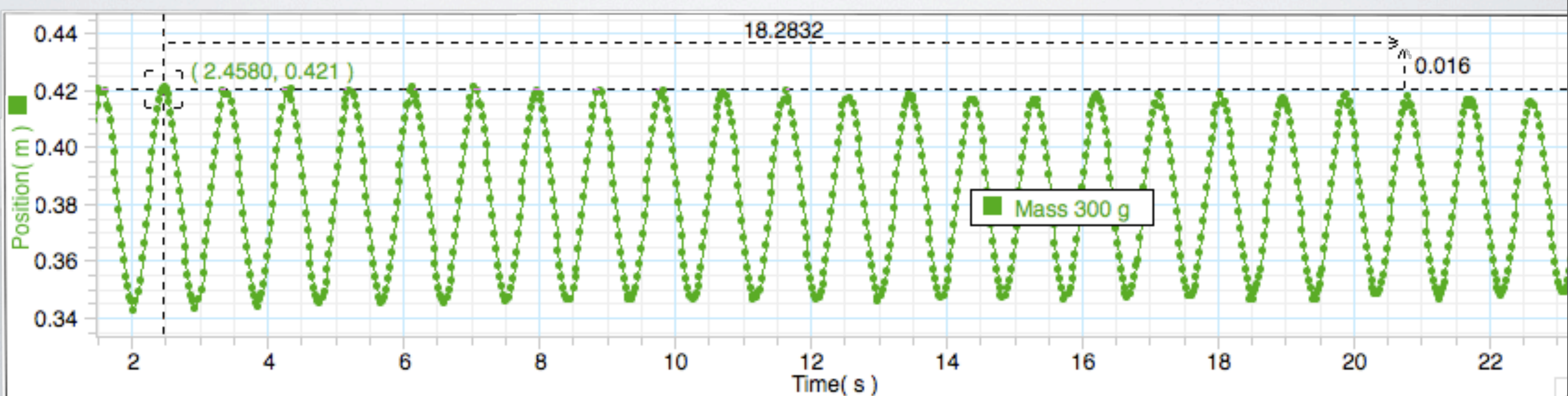
$$T = 2\pi\sqrt{m/k}$$

- Simple Harmonic Motion
- T = Period (s)
- m = Mass (kg)
- k = Spring Constant (N/m^2)



MASS ON A SPRING LAB

$$T = 2\pi\sqrt{\frac{m}{k}}$$



SPRING OSCILLATIONS

- What is the frequency of a 150g mass that hanging from a spring with a 35 N/m spring constant?

$$T = 2\pi\sqrt{\frac{m}{k}}$$

$$T = 2\pi\sqrt{\frac{0.15}{35}}$$

$$T = 2\pi\sqrt{0.0043}$$

$$T = 0.411s$$

$$f = 2.43Hz$$

SPRING HARMONICS