Q2

→ the ~~[illegible]~~ note named A has $f_1 = 440\ Hz$ ||

the speed of sound in Air = 340 m/s

@ $\lambda_A = \frac{v}{f} = \frac{340}{440} = 0.77\ m$

ⓑ Beats per second ?! if the next $f_2 = 466\ Hz$

$f_{beat} = |f_1 - f_2| = 26\ Hz$

$= 26\ s^{-1}$

→ 26 beat in 1 sec.

if transvers-wave with $\lambda = 0.3\ m$ and $T = 10^{-3}\ s$ propagate in $+X$ direction

ⓐ $f = \frac{1}{T}$ $\quad w = 2\pi f$

$= 2\pi \frac{1}{T}$

$\boxed{f = 10^3\ Hz}$

$\rightarrow w = 2\pi * 10^3 \frac{rad}{sec} = 6280 \frac{rad}{sec}$

$\rightarrow v = f * \lambda = 0.3 * 10^3$

$= 300\ m/s$

$\rightarrow K = \frac{2\pi}{\lambda} = \frac{2\pi}{0.3} = 20.9\ m^{-1}$

$\therefore Y = A \cos (kx - wt)$

$= A \cos (20.9x - 6280t)$

ⓑ, ⓒ already solved.

3

Q4 tranverse wave in (+ x) direction

$f = 20\,Hz$ $v = 25\,\frac{m}{s}$

ⓐ $\lambda = \frac{v}{f} = \frac{25}{20} = \boxed{1.25\,m}$

$\omega = 2\pi f = 2\pi \times 20 = \boxed{40\pi\,\frac{rad}{s}} = 126\,\frac{rad}{sec}$

$f = \frac{1}{T} \therefore T = \frac{1}{f}$

$= \frac{1}{20} = \boxed{0.05\,sec}$

$k = \frac{2\pi}{\lambda} = \frac{2\pi}{1.25} = \boxed{5\,m^{-1}}$

ⓑ

$Y = A\cos[5x + 126t]$

Q5 if the wave described by

$$Y = 0.05 \cos(4.19x - 1260t)$$

ⓐ $A = 0.05\ m$

ⓑ $k = 4.19\ m^{-1}$

$$\lambda = \frac{2\pi}{k} = \frac{2\pi}{4.19} = 1.5\ m$$

ⓒ $\omega = 1260\ rad/sec$

$$f = \frac{\omega}{2\pi} = \frac{1260}{2\pi} = 200.6\ Hz$$

ⓓ $v = \lambda f$ travelling speed

$$v = 1.5 \times 200.6$$

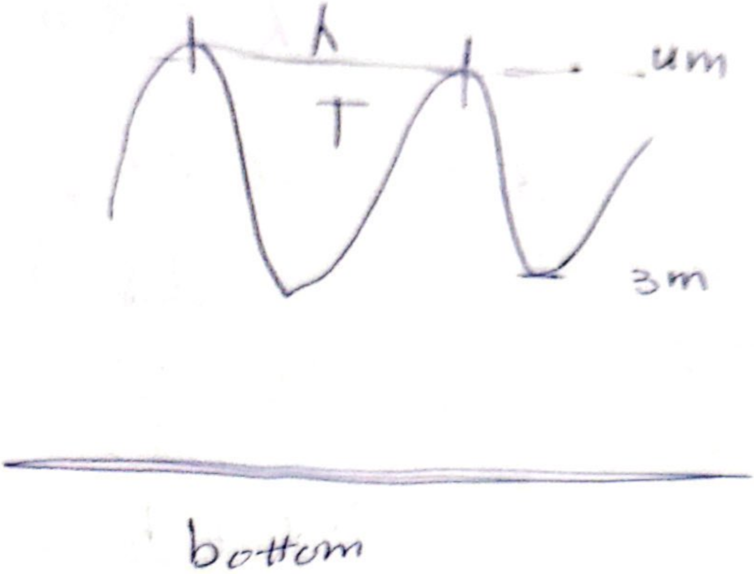
$$= 301\ m/sec$$

ⓔ $V_{max} = A\omega$ Transverse velocity.

$$= 0.05 \times 1260$$

$$= 63\ \frac{m}{s}$$

Q6



$v = 2\,m/s$

$T = 2.9\,s$

find $\lambda = ?!$

Solution:

$$\lambda = \frac{v}{f} \qquad f = \frac{1}{T}$$

$$\lambda = vT = 2 \times 2.9 = 5.8\ m$$

Q7

distance!!

$t = 2.47$ sec

$\lambda = 5.8$ m

$d = \frac{t}{T} \times \lambda$

$= \frac{2.47}{2.9} \times 5.8$

$\boxed{d = 5 \text{ m}}$

$\frac{d}{t} = v \Rightarrow d = vt$

$v = \lambda f$

$\boxed{v = \frac{\lambda}{T}}$

$d = t \frac{\lambda}{T}$ ✓

28

a nose of $f_1 = 1200\,Hz$ first Violin

$f_2 = ??$ second violin

→ if the distinct pulse in the resultant mix which repeat 16 times over the course of 5 sec

Solution:

$f_2 = ??$ $f_{beat} = \frac{16}{5}$ # of cycles passes in a unit time.

$f_b = |f_1 - f_2|$

$\pm f_B = f_1 - f_2$

$\therefore \quad f_2 = f_1 + f_b \quad = 1200 + 3.2$

$= 1203\ Hz$

or

$f_2 = f_1 - f_b \quad = 1200 - 3.2$

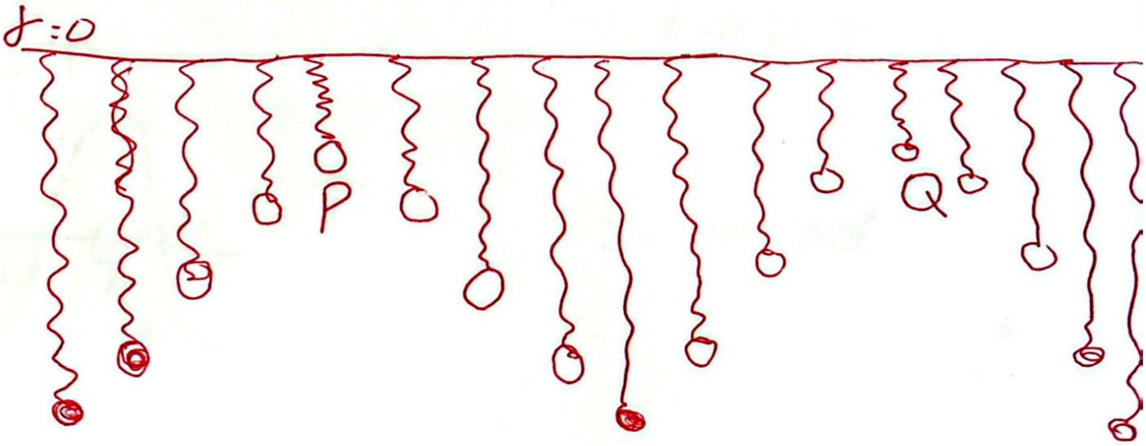
$= 1197\ Hz$

Chapter 8: Waves

- information about the environment is carried by light and sound waves, so these are critical importance to biological organisms
- Energy in the form of heat or light can travel as an EM waves.
- in health-science technology, a large class of diagnostic instruments rely on the propagation and reflection of various kinds of wave like ultra sound, or various kinds of microscopy.

8.2 SHM and waves:

→ when waves propagates, each spatial point on the wave is oscillating in SHM and each oscillator is in a strict phase with every other point.



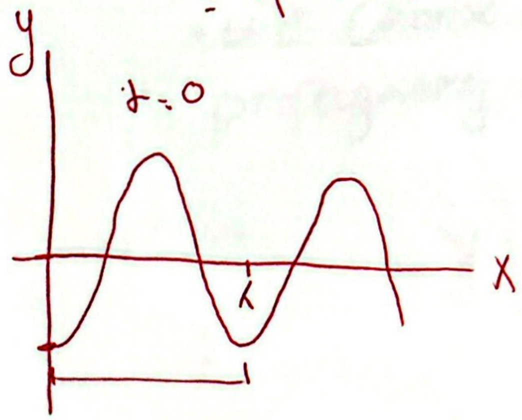
this figure, we represent a wave by a row of mass-spring oscillators, each has the same spring constant, mass and oscilate with the same amplitude.

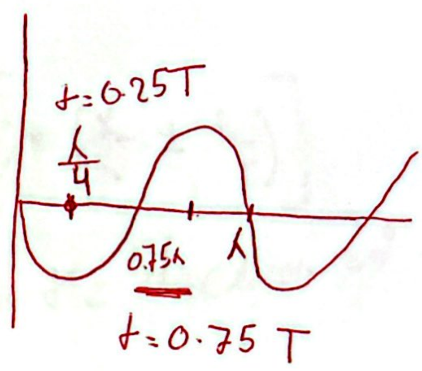
→ This means that they will all oscillate with the same period and freq.

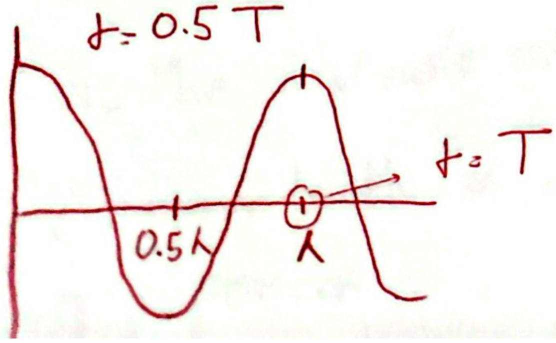
→ each of these spring is oscillating slightly ahead or slightly behind each of its neighbours

→ the distance from spring P to spring Q called wavelength (λ)

* المسافة بين قمتين أو قاعين تسمى الطول الموجي







T = period

∴ freq, wavelength and speed

the speed velocity with which the wave-Crests are travelling

$$v_{wave} = \frac{\Delta x}{\Delta t} =$$

$$= \frac{\lambda}{T} = f\lambda \qquad \boxed{f = \frac{1}{T}}$$

$$\therefore \boxed{v = f\lambda}$$

8.4 : The form of the wave.

- we choose the cosine function to represent propagating wave.

$$Y = A \cos\left[2\pi \left(\frac{x}{\lambda} \pm \frac{t}{T}\right)\right]$$

* plus/minus symbol: indicates the direction of travel

A: the amplitude of the wave.

λ: wavelength (# of meter per wave cycle)

T: period.

$k = \frac{2\pi}{\lambda}$ k: the wavenumber (How many cycles per me[ter])

$\omega = 2\pi f$ w: angular freq (rad per sec)

(specifically, it is the angle in radians travelled through by that # of cycles)

<u>then</u>: the expression for a wave become

$$Y = A \cos[kx \pm \omega t]$$

phase of the wave

varing the phase can be achieved by ~~the~~ changing the point under observation (i.e, changing x) or (changing t) ...

this plus/minus sign, represent a wave travelling

"+" travelling in negative x direction

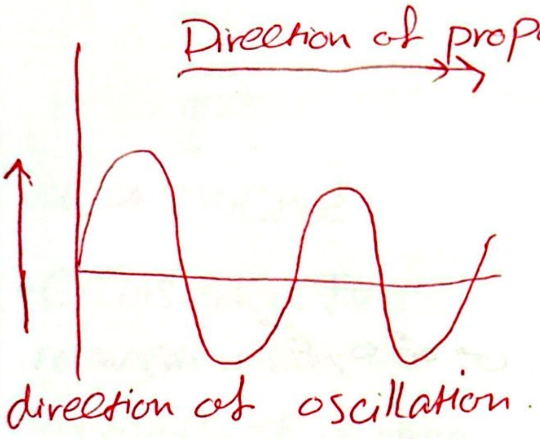
"−" " " positive x direction.

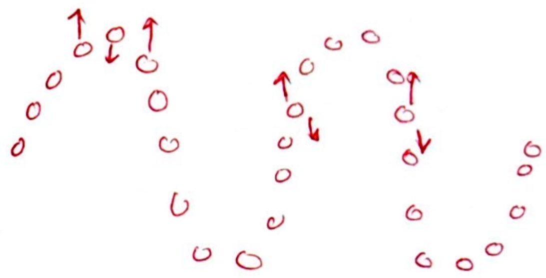
Q5: Types of Waves

1. Transverse waves:

is one in which the medium in which the wave is travelling is oscillating in a direction which is perpendicular to the direction in which the wave is propagating.

Example of this kind: Electromagnetic waves.





2. Longitudinal waves:

each spatial point in the medium in which the wave is propagating is oscillating in the same direction the wave is propagating.

Example: pressure wave in air that we experience as sound.

Chapter 1:

1.6 Superposition and Interference

Q: what happens when two waves meet and overlap?

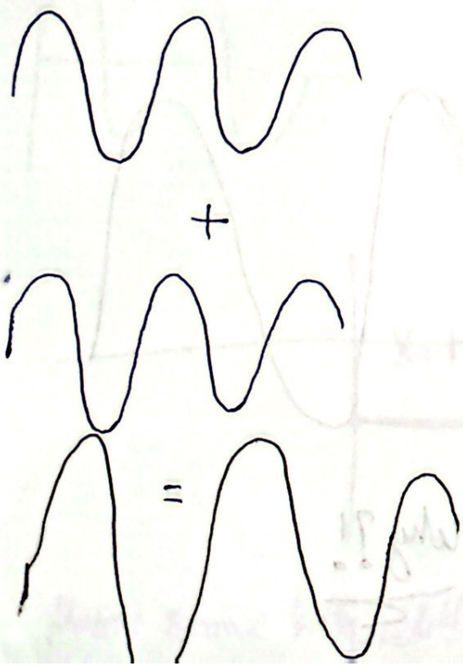
* Superposition: is the combination of two waves at the same location.

* The primary phenomenon which results from the superposition is Interference.

Interference "at its extremes

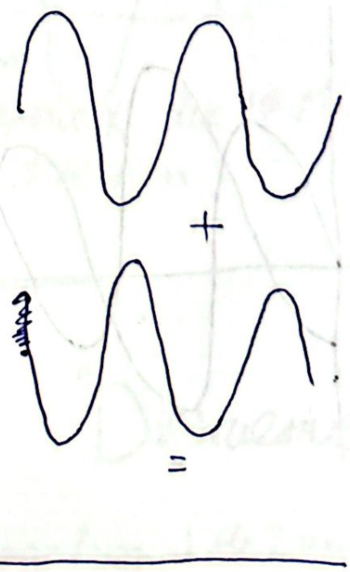
Constructive

- Occurs when two identical waves are superimposed in phase



Destructive

- Occurs when two identical waves are superimposed out of phase.



General cases :-

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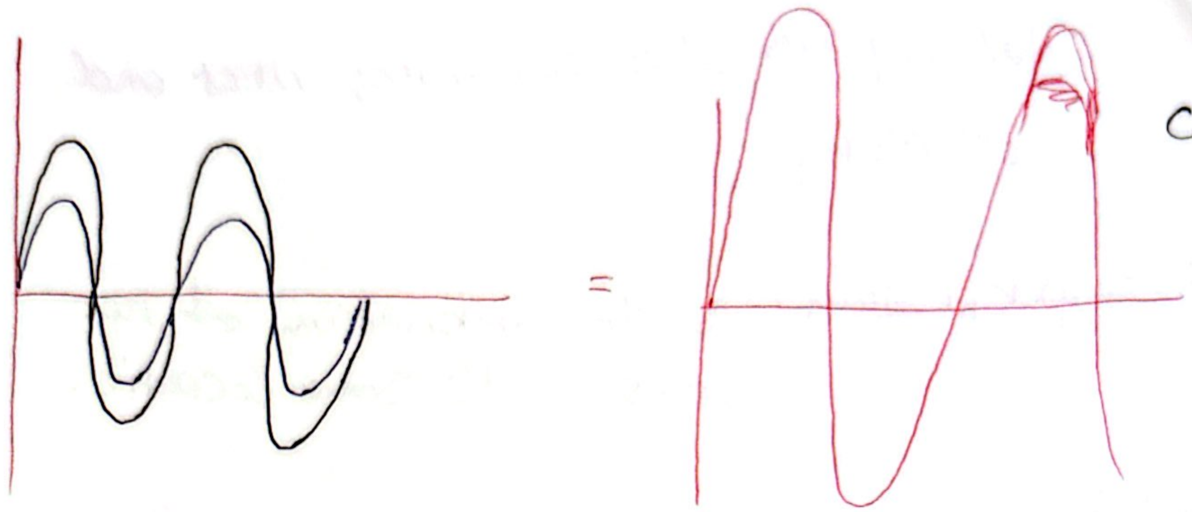
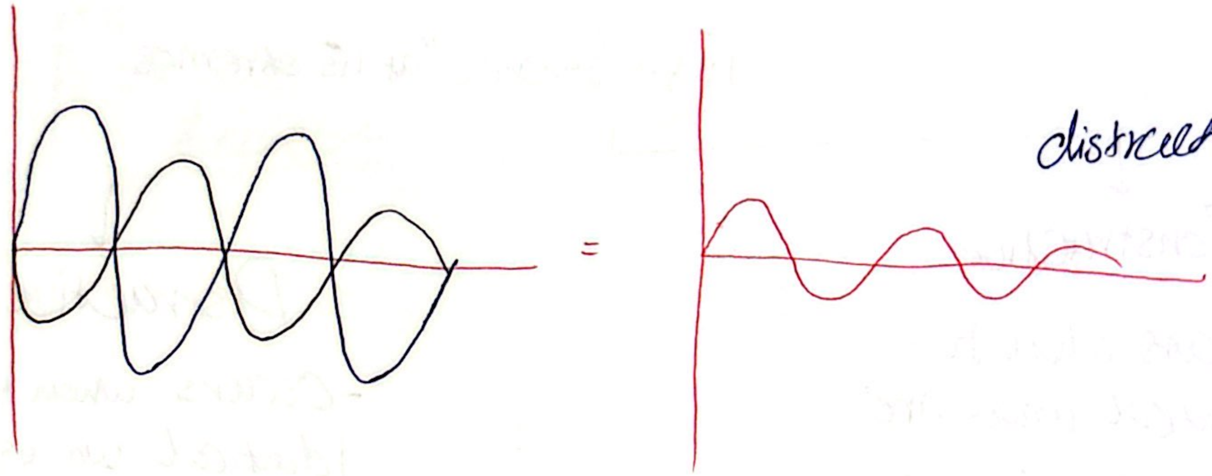
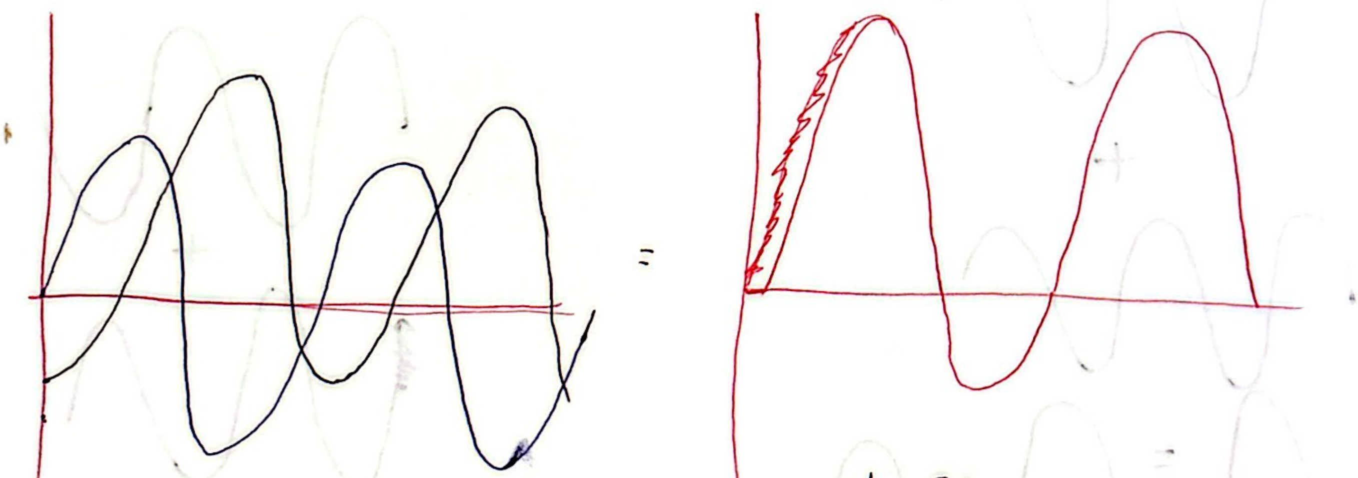


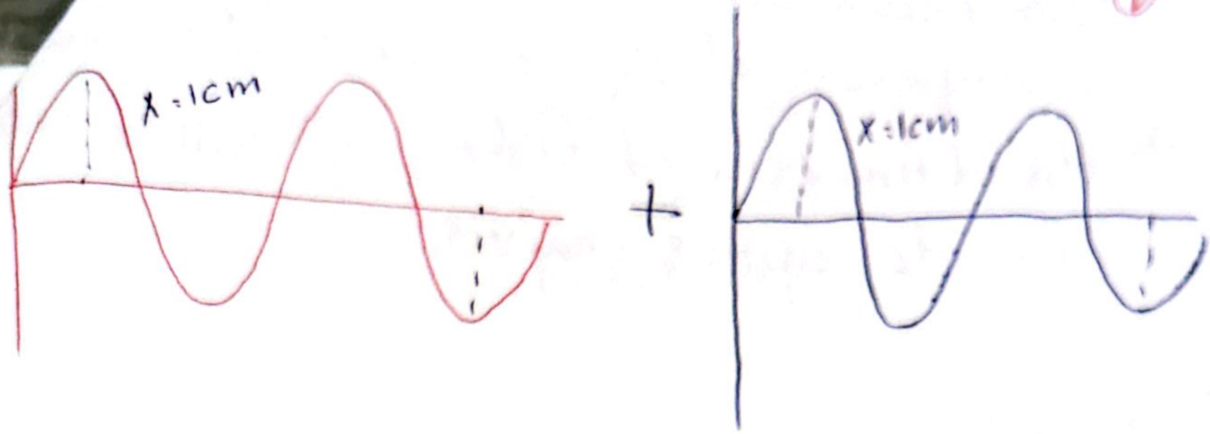
Constru



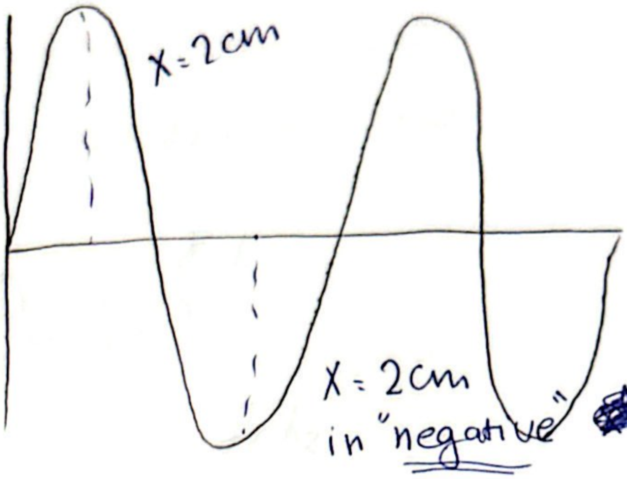
distructive



why ?!



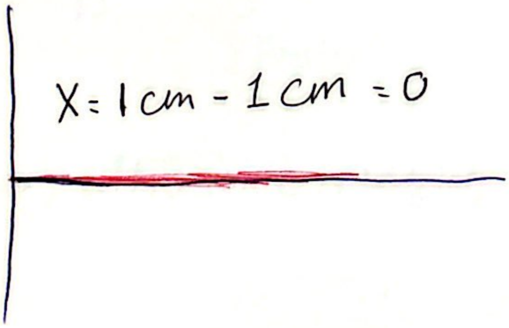
"Constructive"



like dealing with vectors.

Case 2

negative X due to the direction.



"Distructive"

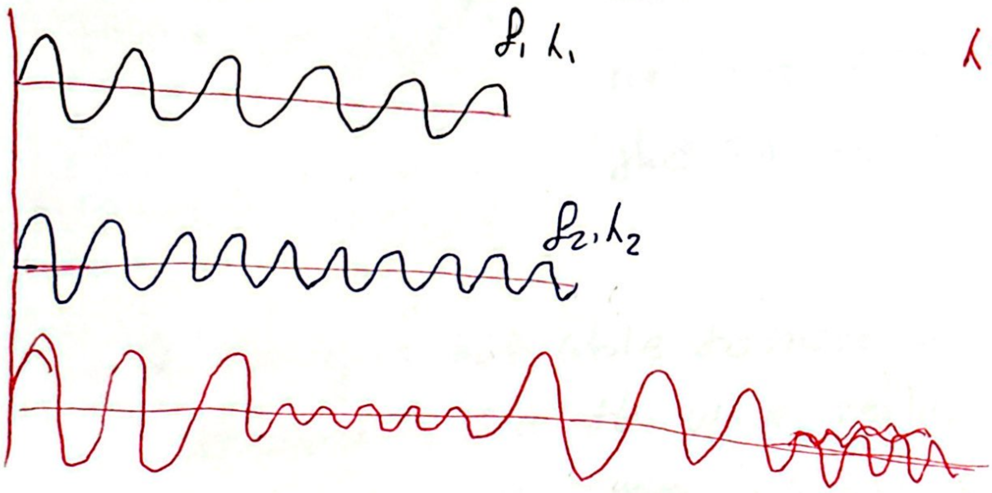
Note: same freq, diffrent amplitude = average freq of the 2 waves.

→ For health sciences, one of the most handy consequences of the interference of waves is the diffraction of light, this will be seen in the optics chapter.

Beats:

Beats produced by the superposition of two waves with identical amplitude with diffrenet freq.

→ So the two waves go in and out of phase which leads to alternately constructive and distructive interference



λ: wavelength

→ This wave fluctuates in amplitude or (beats) with freq called the beat freq.

$$f_B = |f_1 - f_2|$$

by some algebra and trigonometry

Example:
piano, ultrasonic imaging, radar speed.

Reflection

* when a wave hit a wall or attachment point, it reflect in opposite direction

Case 1 : fixed attachment point.

- when a pulse travelling along ~~a piece~~ a piece of string and reflecting from a post to which the string is attached.

→ the string is not able to move at the point of attachment, then the wave reflects and travels back along the string "upside down"

② with phase shift π (Eq (8.2) and (8.5))
if you add π to the phase

③ → The result will be a wave which is half a wave travelling in the opposite direction

① → at the fixed point the amplitude = zero
The only way to get this is if the reflected wave has the same amplitude but in the opposite direction with phase shift = π

- Movable attachment :-

→ Since the attachment point is not fixed the reflected wave does not have to shift by π with respect to incoming wave.

→ The reflected pulse travels back along the wave with the same orientation as the incoming wave.

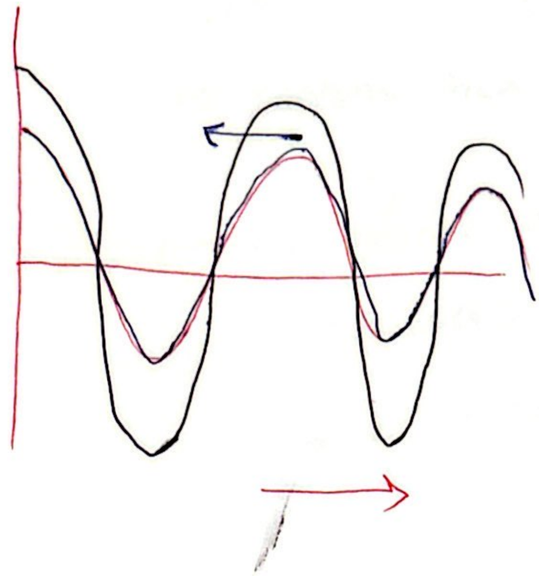
→ The incoming and reflected waves will superpos at the attachment point and gives a wave wich has ~~the~~ twice the amplitude of the incoming wave on it's own.

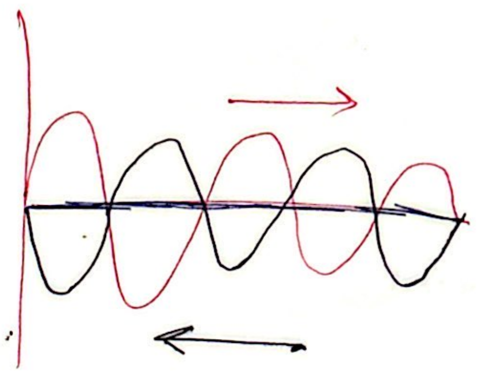
	* fixed	movable.
phase shift	π	Zero
amplitude at the attachment.	equal amplitude opposite direction superpose = Zero	equal amplitude same direction superpose = 2 amplitude
amplitude of the reflected wave	$\frac{1}{2}$ the original. opposite direction	same as the original same direction

Char

when we have 2 waves with the same λ, f and speed, but travelling in opposite direction through the same medium, we get standing waves

→ if the two wave are incoming to a barrier, travelling in opposite direction





* the resultant wave due to the superpose dont propagate, only oscillate up, down, thats why it's called "standing" "waves"

10: Waves and Energy

Energy

Waves have two extremely useful characteristics

1. transmit energy from one place to another

like lasers (1), Sounds (music) (2), earthquakes (3)

one instance at the transmission of energy

this waves called seismic waves.

(4) water waves may cause significant damage to coastal areas during storms like tsunami

2. transmit information from one Place to another

like radio wave ⟶ to transmit voice messages text messages and data between cell phone and computers.

light wave ⟶ transmit information about the world into our eyes

sound waves ⟶ transmit information into our ears.

Recall

→ when we describe the waves → sequence simple harmonic-oscillators

* each one of these oscillators has the same amplitude and freq

∴ the the potential energy stored in Mass-Spring oscillator is given by

$$P.E = \frac{1}{2} k A^2$$

where A: the amplitude of oscillation of the mass-spring system

The General Case: The energy transmitted by a wave is proportional to the square of the amplitude of that wave

Chapt

power: How much energy is transmitted per unit time

$$P = \frac{W}{t}$$

Intensity: is measure of how much power per unit area (watts per square metre)

$$I = \frac{P}{A}$$

→ The sun is the most important source of energy, where the energy produced by the nuclear fusion processes operating in the sun transmitted to the earth as EM waves. "sunlight"

→ on clear day, sun provides about $1\,kw.m^{-2}$

in summer

I = around 1000 J of energy arrive on every square meter ~~exposed~~