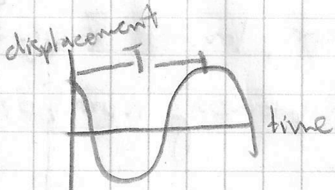
Final Exam Review

(Just the last section)

Waves / Vibrations

$f = \frac{1}{T}$ ← the period

↗ Frequency



$x(t) = A\cos(\omega t + \phi)$

- $x(t)$ ← position w/ respect to time (like a spring going up and down)
- A ← amplitude (highest displacement)
- ω ← Angular Frequency
- t ← time
- ϕ ← phase shift

If we take the derivative with respect to time:

$$\underbrace{\frac{d}{dt}x(t)}_{\rightarrow v(t)} = -\omega A \sin(\omega t + \phi)$$

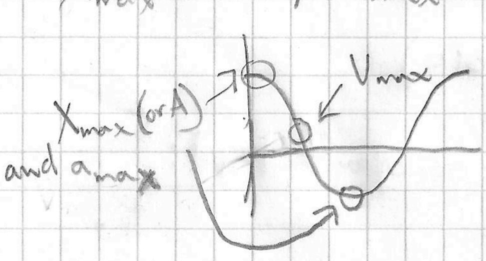
velocity!

Again...

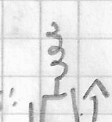
$$\underbrace{\frac{d}{dt}v(t)}_{a(t)} = -\omega^2 \sin(\omega t + \phi)$$

$a(t)$ ← acceleration!

$X_{max} = A$; $V_{max} = \omega A$; $a_{max} = \omega^2 A$



, which could look like a spring/mass:



Pipes

General: *Importint term: "Fundamental Frequency" or "First Harmonic"
which means lowest frequency.

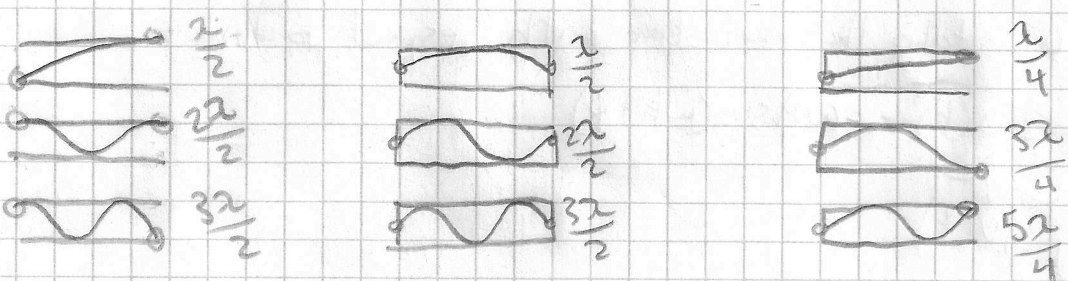
* "n" → frequency number

* $f_n = nf_1$

freq. at #n (↑ f_n), Fundamental (↑ f_1)

* All closed ends have a node, open ends have an antinode

open/Open Closed/closed open/closed



Each of these represent the first three harmonics for differing pipe geometry.

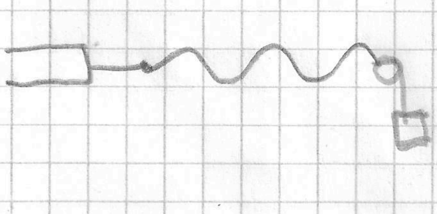
For each, the wavelengh decreases so that an additional λ/2 is able to fit. Generally,

open/open & closed closed: $L = \frac{n\lambda}{2}$ (L ← length of pipe, n ← # of harmonic, λ ← wavelength) $n = (1, 2, 3, \text{etc})$

open/closed: $L = \frac{n\lambda}{4}$ $n = (1, 3, 5, \text{etc})$

Notes:

A vibrator, like below, acts like an open-closed:



Sound

Power (in watts)

$$I = P/A$$

I ← Sound intensity; A ← area (in m^2)

Important: the area will be πr^2 if the wave is Planar (a 2-D wave)
or $4\pi r^2$ if it is Spherical
(which means it propigates in all directions evenly)

Sound Intensity: I in W/m^2
Sound Level: β in decibels
↳ cannot add like ~~$\beta_{tot} = \beta_1 + \beta_2$~~ Does not work

Instead, convert to Intensity then add:

$$I = I_0 10^{(\beta/10)}$$

I_0 ← 10^{-12} or 1×10^{-12}

$$\beta = 10 \log(I/I_0)$$

log ← log base 10

Doppler

$$f' = f\left(\frac{v \pm v_o}{v \pm v_s}\right)$$

- f' ← frequency heard by observer
- f ← frequency emmitted
- v_o ← Velocity of observer (+ if approaching)
- v_s ← Velocity of source (+ if leaving)