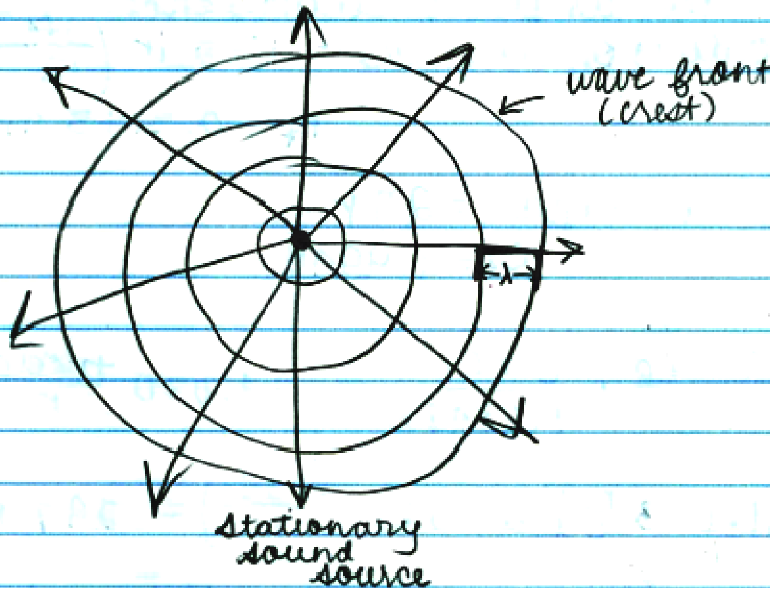
Video Lecture #1 – Introduction to the Basics of Sound using a Tuning Fork - Speed of Sound in Air

Thank You, Puja Patel, for these notes.

Human audible range is ≈ 20 - 20000 Hz
we don't hear frequency, we hear pitch

$$V = 331 + 0.6T_c$$

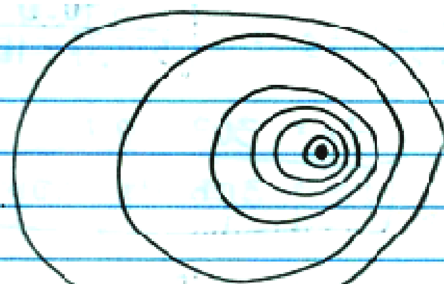
speed of sound in air is temperature dependent



Video Lecture #2 –Introduction to the Doppler Effect

away from us

λ increases
f decreases



toward us

λ decreases
$f = \frac{v}{\lambda}$
f increases

sound source moving towards the right

Doppler Effect

$$f_o = \left(\frac{v}{v \mp v_s}\right) f_s$$ − s toward o, + s away from o

$$f_o = \left(\frac{v \pm v_o}{v}\right) f_s$$ + o toward s, − o away from s

s ⇒ source
o ⇒ observer
v = speed of sound

Doppler Bike

$\Delta X = 60.0\ m$

$\Delta t = 5.453\ s$

$V = \frac{\Delta X}{\Delta t} = \frac{60}{5.453} = 11.00311755\ \frac{m}{s} = V_s$

54 treads per circumference

radius of the tire $= 12\frac{1}{2}\ in \left(\frac{1ft}{12''}\right)\left(\frac{1m}{3.281ft}\right) =$

$r_t = 0.3175\ m$

circumference $= 2\pi r$

$C_t = 1.9948$

$\frac{54\ tred}{circ.} \cdot \frac{circ.}{1.9848\ m} = 27.070\ \frac{treads}{m}$

$f_s = \left(11.003\ \frac{m}{s}\right)\left(27.070\ \frac{treads}{m}\right) = 297.856\ \frac{treads}{sec}\ Hz$

$f_o = \left(\frac{V}{V \mp V_s}\right) f_s = \left(\frac{340.\overline{6}}{340.\overline{6} - 11.003}\right) 297.856$

$f_o = 307.797$

$f_o \approx 308\ Hz$ towards

$T_f = 61°F$

$T_c = (T_F - 32)\frac{5}{9}$

$T_c = (61 - 32)\frac{5}{9}$

$T_c = 16.11°C$

$V = 331 + 0.6\,T_c$

$= 331 + 0.6(16.11)$

$= 340.6\ \frac{m}{s}$

$f_o = \left(\frac{V}{V + V_s}\right) f_s$

$= \left(\frac{340.\overline{6}}{340.\overline{6} + 11.003}\right) 297.856$

$= 288.537$

$f_o = 289\ Hz$ away

Video Lecture #4 – Introduction to the Intensity of Sound and Human Hearing

Intensity

$$I = \frac{P}{A} = \frac{P}{4\pi r^2} \qquad \boxed{I = \frac{P}{4\pi r^2}} \quad \frac{\text{watts}}{m^2}$$

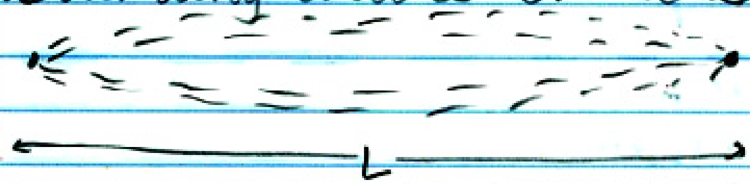
Video Lecture #5 – Introduction to Resonant Frequency (no lecture notes)

Video Lecture #6 – Introduction to Supersonic Speeds and the Sonic Boom

sonic boom is the wake of something moving super sonically

Video Lecture #7 – Deriving the Frequencies for a Stringed Instrument – Standing Waves on a String

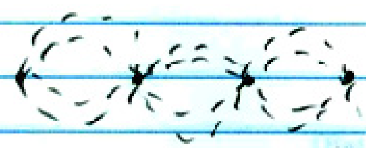
standing waves on a string



$\frac{1}{2}\lambda = L$, $\lambda = 2L$

$f = \frac{v}{\lambda} = \frac{v}{2L}$

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



$\frac{3}{2}\lambda = L \qquad f = \frac{3v}{2L}$

$$\boxed{f = N\left(\frac{v}{2L}\right)}$$

n = Harmonic #

N = 1 ⇒ fundamental frequency

stringed instrument & open piped instrument

N = 2 = 2nd hermonic

N = 1 = 1st hermonic

Video Lecture #8 – Deriving the Frequencies for Wind Instruments with an Example Problem

open pipe (open on both end)

closed pipe (open on one end)

open end ⇒ Antinode   closed end ⇒ node

closed pipe instrument

$$\boxed{f = m\left(\frac{V}{4L}\right)} \quad m = 1, 3, 5, 7 \ldots$$ * only odds!

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example) $L = 2.375$ m

$L_{adj} = L + 0.4D(\times 2)$

$= 2.375 + 0.4(0.13 m)(\times 2)$

$L_A = 2.4838$ m

$v = 331 + 0.6T_c$ $T_c = 22.8°C$

$v = 331 + 0.6(22.8)$

$v = 344.68 \frac{m}{s}$

$f = \frac{NV}{2L}$ $f_2 = \frac{NV}{2L}$

$f_1 = \frac{1(344.68)}{2.4838}$ $f_2 = \frac{2(344.68)}{2.4838}$

$f_1 = 69.3856188$ $f_2 = 138.7712376$

≈ 69 Hz ≈ 140 Hz

Video Lecture #9 – An Introduction to the Physics of Musical Theory (Thank You, Sangini Tolia, for these notes.)

Timbre ("tambre") - interplay of harmonics on an instrument

12 note chromatic half step musical scale - concert pitch above middle C → A 440 Hz

$A\,440\text{ Hz} \times 2^{\wedge(\frac{1}{12})} = A\#$

$n=1$ $f_1 = 440$ Hz

$n=2$ $f_2 = 2(f_1) = 880$ Hz.

Video Lecture #10 – An Introduction to Beat Frequency with Demonstration

Beat frequency: $f_b = |f_1 - f_2|$

Video Lecture #11 – The Basics of the Physics of a Guitar (no lecture notes)

Video Lecture #12 – Butterfly Face - A Song that has Nothing to do with Physics, sorry. (no lecture notes)