Notes 4/19/10

time $\begin{cases} T: \text{period} \\ f: \text{frequency} \\ \omega: \text{angular frequency} \end{cases}$ $T = \frac{1}{f} = \frac{2\pi}{\omega}$

time & space $\{ V: \text{wave speed} \}$ $v = \frac{\lambda}{T}$

space $\begin{cases} \lambda: \text{wavelength} \\ k: \text{wave number} \end{cases}$ $\lambda = \frac{2\pi}{k}$

Sound: $v = 343\ m/s$

(what we hear is frequency from sound)

Guitar

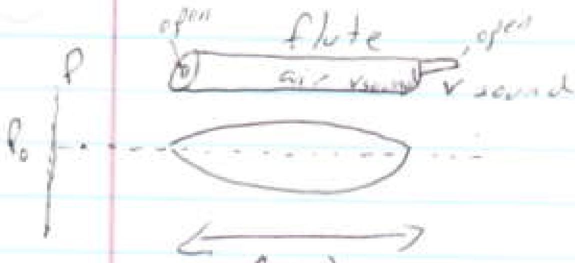
fundamental frequency = 1st harmonic = $f_1 = \frac{V_{string}}{\lambda_1} = \frac{V_{string}}{2L}$

$$V = \frac{\lambda}{T} = \lambda f \Rightarrow f = \frac{V}{\lambda}$$

$$l = \frac{\lambda_1}{2} \Leftrightarrow 2l = \lambda_1$$

$V_{string} = \sqrt{\frac{F_T}{M}}$

(The frequency stays the same when the string is play)



(velocity of sound changes, the fundamental of frequncy changes)

$l = \frac{\lambda_1}{2}$

λ_1 fixed

V_{sound} changes $\Rightarrow f_1 = \frac{V_{sound}}{\lambda_1}$ changes

$\boxed{\text{✱ Sound : } v = 343\ m/s}$

1st

open

$\lambda = \frac{\lambda_1}{2}$

1st harmonic

2nd

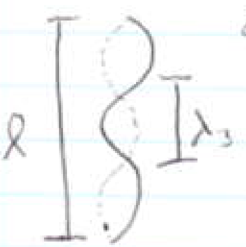
second harmonic

fix pressure

open

$l \cdot \frac{2\lambda_2}{2} = \lambda_2$

3rd harmonic

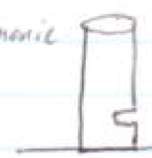


open

$l = \frac{3\lambda_3}{2}$

fundamental or 1st harmonic

$l = \frac{\lambda_1}{4}$



close

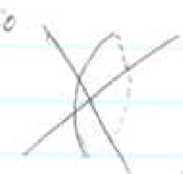
no second harmonic bo the end having to mach air pressure.

longest wave length it could have is this

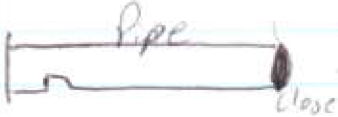
3rd because of ratio

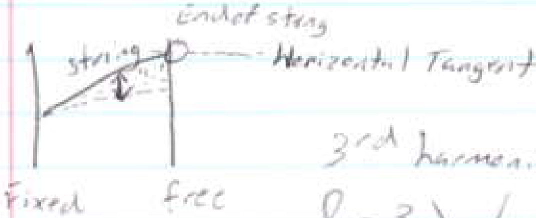
3rd harmonic

$l = 3\lambda_3/4$



no second





3rd harmonic

$l = 3\lambda_3/4$

$\lambda_3 = \frac{4l}{3}$

$\lambda_3 = \frac{\lambda_1}{3}$

$f_3 = 3f_1$

no 4th harmonic, but we do have a 5th harmonic like this

5th harmonic

$l = 5\lambda_5/4$

$\lambda_5 = \frac{4l}{5}$

$\lambda_5 = \frac{\lambda_1}{5}$

$f_5 = 5f_1$

Whether both ends open or just one end open, the difference between subsequent harmonic is the same.

$v = \lambda f$

both closed

$\lambda_1 = 2l \Rightarrow f_1 = \frac{v}{2l}$

$\lambda_2 = \frac{2l}{2} \Rightarrow f_2 = \frac{2v}{2l}$

$\lambda_3 = \frac{2l}{3} \Rightarrow f_3 = \frac{3v}{2l}$

one closed

$\lambda_1 = 4l \Rightarrow f_1 = \frac{v}{4l}$

$\lambda_3 = \frac{4l}{3} \Rightarrow f_3 = \frac{3v}{4l}$

$\lambda_5 = \frac{4l}{5} - f_5 = \frac{5v}{4l}$

$f_5 - f_3 = \frac{2v}{4l} = \frac{v}{2l}$

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Angular frequency

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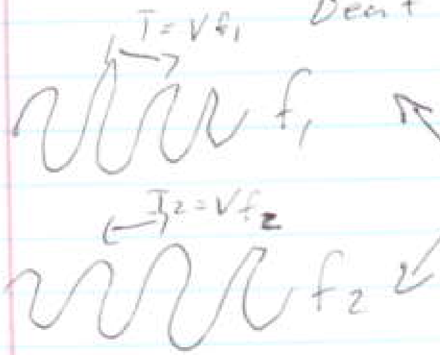
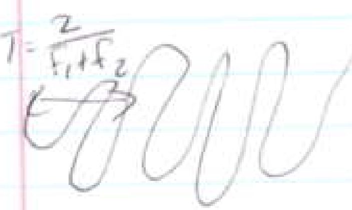
the human ear cant hear more than 20 hertz frequency of the beats, has the longer period so frequency is smaller.

Beat frequency $= \frac{f_1 - f_2}{2} = f_{beat}$

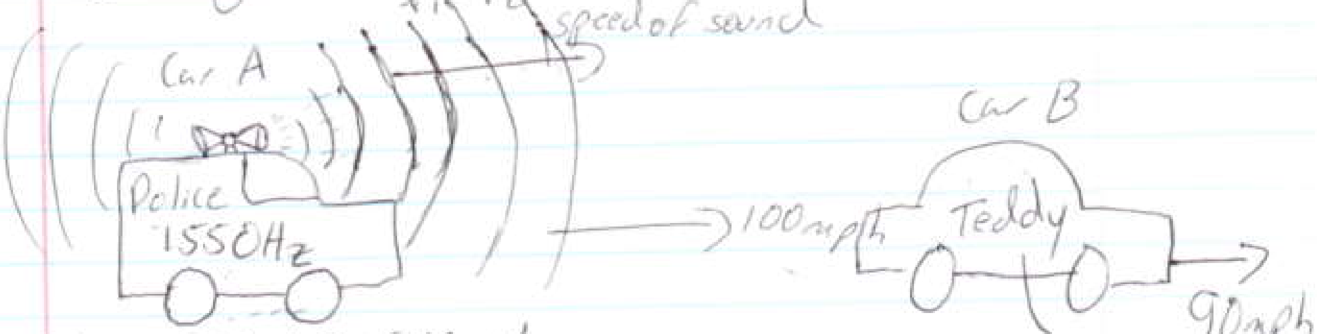


(both instruments) the Resiprical of the Beat

1mps = 2.8mph



$\frac{2}{f_1 - f_2} = T_{beat}$



$V_{sound} = 343\,m/s \approx 800mph$

$f_A = 1550\ Hz$

What frequency does this driver hear?

next

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for general formula

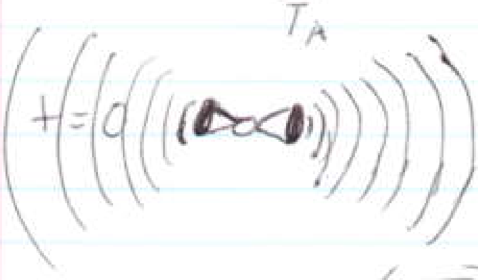
$\lambda = ?$

$V_{sound} = \frac{\lambda}{T_A}$

$\boxed{\text{Car A}}$

$T_A = \frac{1}{f_A}$

$t=0$



one period later

$t = T_A$

$V_{snd} \times TA$

λ

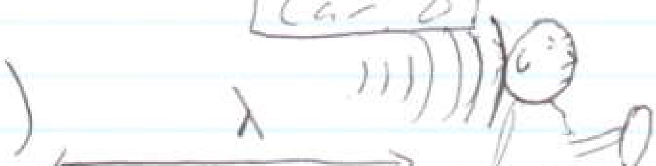
$$\lambda = V_{sound} T_A - V_A T_A$$

$$\lambda = (V_{snd} - V_A) T_A$$

$\boxed{\text{Car B}}$

$t=0$

λ



$(V_{snd}) - (V_B)$

period of sound of hearing

$$T_B = \Delta t = \frac{\lambda}{V_{snd} - V_B} = f_B = \frac{1}{T_B} = \frac{V_{snd} - V_B}{\lambda} = \frac{V_{snd} - V_B}{(V_{snd} - V_A)} \cdot \frac{1}{T_A}$$

formula

$$\boxed{\left(\frac{V_{snd} - V_B}{V_{snd} - V_A}\right) f_A}$$