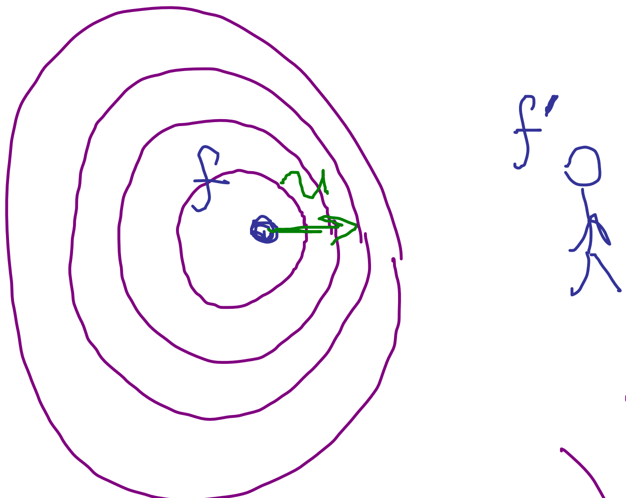
Phys 2110-4   4/29/13

Note Title   4/29/2013



$$\boxed{f' = f\left(\frac{1}{1 \mp u/v}\right)}$$

$-$ Toward
$+$ Away

u = speed of source

Effectively, wavelength has been shortened

$T = 1/f$

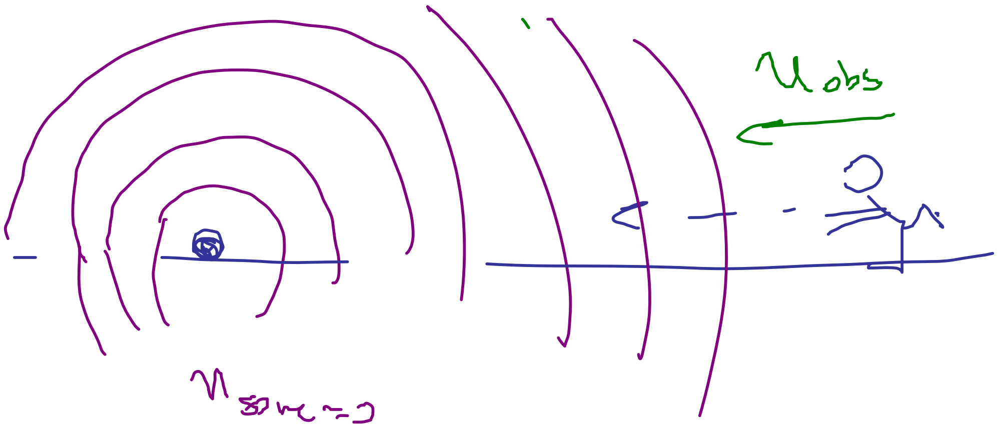
$$\lambda' = \lambda - uT$$

Stick figure

$$\lambda' f' = v$$

$$f' = \frac{v}{\lambda - uT} = \frac{v}{\frac{v}{f} - \frac{u}{f}} = f\left(\frac{v}{v-u}\right)$$

$$\boxed{= f\left(\frac{1}{1-u/v}\right)}$$



You hear higher freq because effectively speed of waves is greater

λ same. (f')

Man

$$\lambda f' = v'$$

v = speed of sound

$$\frac{v}{f} f' = v + v_{obs}$$

$$f' = \frac{f}{v}(v + v_{obs})$$

$$v f' = f(v + v_{obs})$$

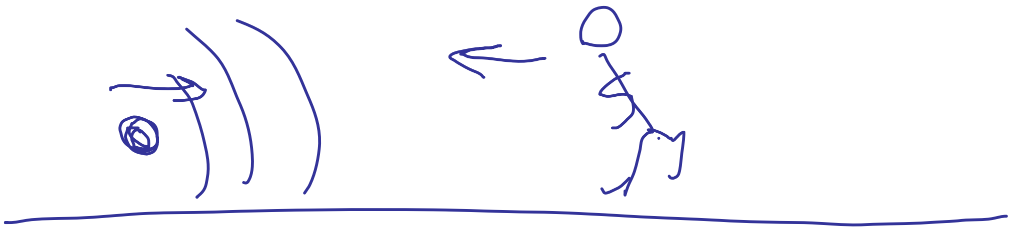
$$\boxed{f' = f\left(1 + \frac{v_{obs}}{v}\right)}$$

Moving observer

$$f' = f\left(1 \pm \frac{v_{obs}}{V}\right)$$

Toward

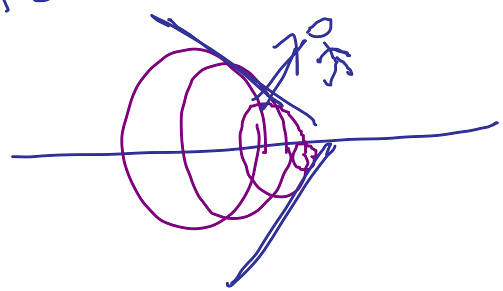
Away



$$f' = f\left(\frac{1 \pm \frac{v_{obs}}{V}}{1 \mp \frac{v_{source}}{V}}\right)$$

General case

For these $v_{source} < V$



shock

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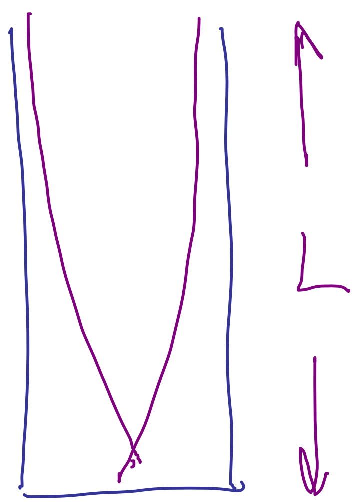
Doppler effect for light Requires a diff formula.

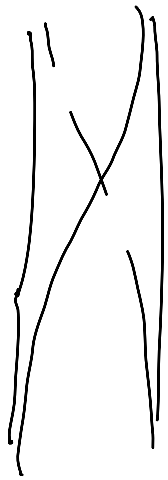
14.70 Lowest note of organ is 22 Hz
Length of pipe necessary if a) Closed one
b) Open both

a)



$$L = \frac{\lambda}{4} = \frac{1}{4}\frac{v}{f}$$

$$= \frac{1}{4}\frac{340\,\frac{m}{s}}{22\,\frac{1}{s}} = 3.9\ m$$

b)  $L = \frac{\lambda}{2} = \frac{1}{2}\frac{v}{f} = \frac{1}{2}\frac{340\,\frac{m}{s}}{22\,\frac{1}{s}} = 7.8\,m$

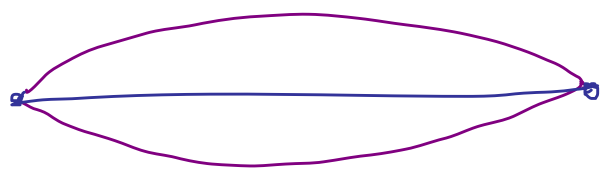
14.68 A-string in piano is 440 Hz

Is 38.9 cm long. Clamped on both ends.

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

$F = 667\,N$. Find mass of string.

$= \frac{1}{2}\frac{v}{f}$



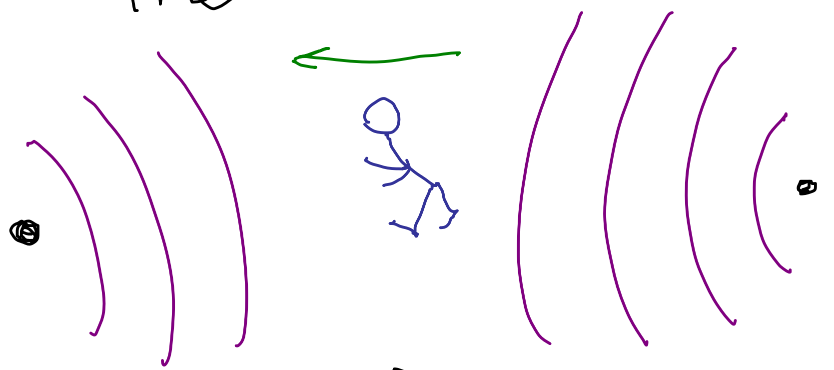
Find $v = 342\,\frac{m}{s}$

$$v = \sqrt{\frac{F}{\mu}} \qquad \mu = \frac{F}{\left(342\,\frac{m}{s}\right)^2} = 5.69 \times 10^{-3}\ \frac{kg}{m}$$

$$\text{Mass of string} = \mu L = 2.2 \times 10^{-3}\ kg$$

$$= 2.2\ g$$

14.74 You're between two loudspeakers emitting 180-Hz tones. How fast would you have to move to perceive a beat frequency of 1.5 Hz between the two?



Moving observer

$$f' = f\left(1 \pm \frac{u_{obs}}{v}\right)$$

Given $\Delta f = f_{tow} - f_{away} = 1.5\ \text{Hz}$

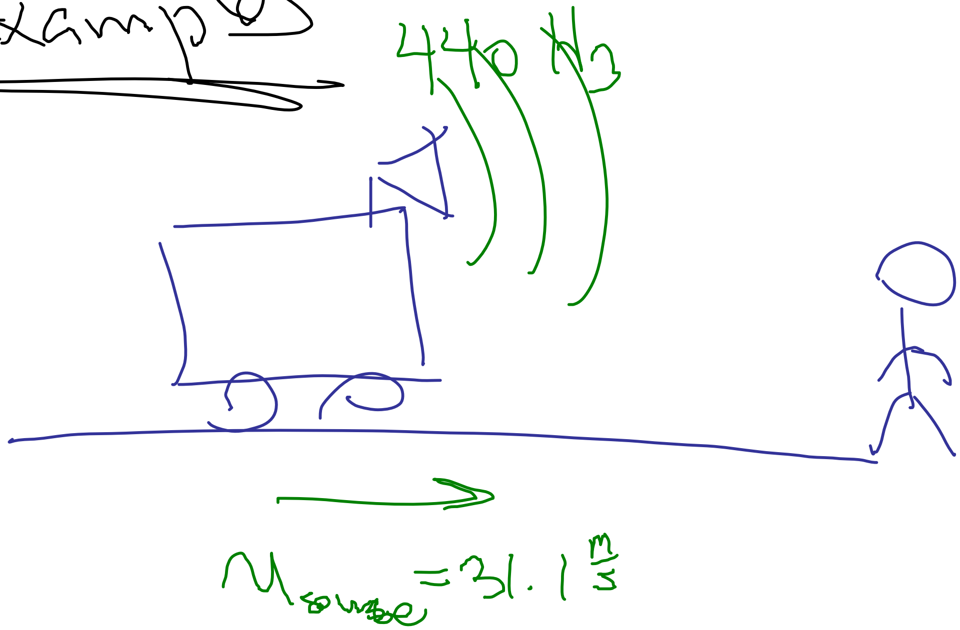
$$= f\left(\cancel{1} + \frac{u_{obs}}{v}\right) - f\left(\cancel{1} - \frac{u_{obs}}{v}\right) = 1.5\ \text{Hz}$$

$$2f\frac{v_{obs}}{v} = 1.5\ Hz \qquad f = 180\ Hz$$

$$v_{obs} = \frac{1.5\ Hz}{180\ Hz}\ \frac{v}{2} \qquad v = \text{speed sound}$$

$$v_{obs} = 1.43\ \frac{m}{s}$$

Examples



car goes down road playing concert A to people standing front.

What freq do they hear?

$$f' = f\left(\frac{1}{1 - \frac{v_{source}}{v}}\right) = (440\,Hz)\left(\frac{1}{1 - \frac{31.1\,\frac{m}{s}}{343\,\frac{m}{s}}}\right)$$

$$= 484\,Hz$$

14.78