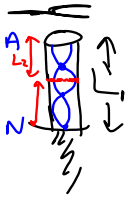
H/W – water trombone



(a) resonance when
$L = 27\,cm, 45\,cm$
L_2 L_1
and none in between
two consecutive modes
$L = \frac{\lambda}{4}$ or $\frac{3\lambda}{4}$ or $\frac{5\lambda}{4}$
Here, we are changing L

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So $\frac{3\lambda}{4} = 27\,cm$ $\frac{5\lambda}{4} = 45\,cm$

$\Rightarrow \lambda = 36\,cm$

Prediction: expect resonance when
$L = \frac{\lambda}{4} = 9\,cm$

To estimate f, use $v = f\lambda$
$330\,ms^{-1}$ $0.36\,m$

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(b) where does extra energy come from? (amplifier)
from tuning fork.
(it is damped by standing wave in air column)

Speed of sound

$v = \sqrt{\frac{B}{\rho}}$ B ← bulk modulus "incompressibility"
ρ ← mass density (inertia)
$v = \sqrt{\frac{T}{m/l}}$

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In gases, we can write expression for B (preview)

$B = \gamma P_0$ ← equil. pressure e.g. 100 kPa in air
ratio of heat capacities
$\gamma = \frac{7}{5}$ for N_2, O_2, any diatomic gas
$\Rightarrow B \sim 1.4 \times 10^5\,Pa$ in this room

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also need $\rho = \frac{N \leftarrow \text{no. moles} \times M \leftarrow \text{molecular weight}}{\text{volume}}$

use ideal gas law $PV = NRT$ ← const.

$\Rightarrow v = \sqrt{\frac{B}{\rho}} = \sqrt{\frac{\gamma RT}{M}}$ (check)

$\rightarrow 340\,ms^{-1}$

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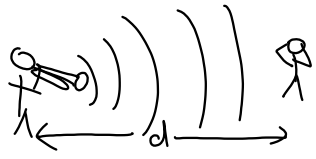
Intensity
power per unit area (Wm^{-2})

Note that power falls off with distance from source.
as $\frac{1}{d^2}$



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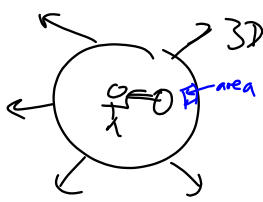
Cons. of energy



3D - spread total energy over a sphere

We know surface area of sphere $\propto$ radius^2

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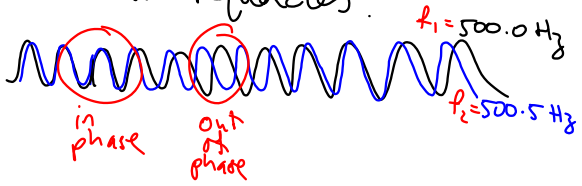
Beats

two sources with slightly different frequencies.



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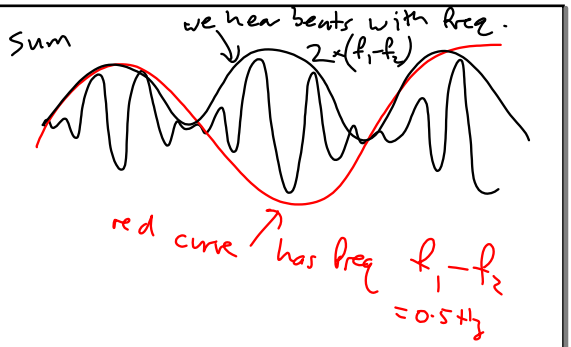

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We hear modulation of amplitude
rel. slow variation
with freq. 2 x freq. difference

useful to tune musical instruments.

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Doppler effect

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