PHY117 HS2023

Week 12, Lecture 1
Dec. 5th, 2023
Prof. Ben Kilminster

Last time, standing waves:
in general

$$y(x,t) = 2A\cos\omega t \sin kx$$

where $k_n = \frac{n\pi}{L}$ + $\omega_n = k_n v$ + $v = \frac{\omega}{k}$

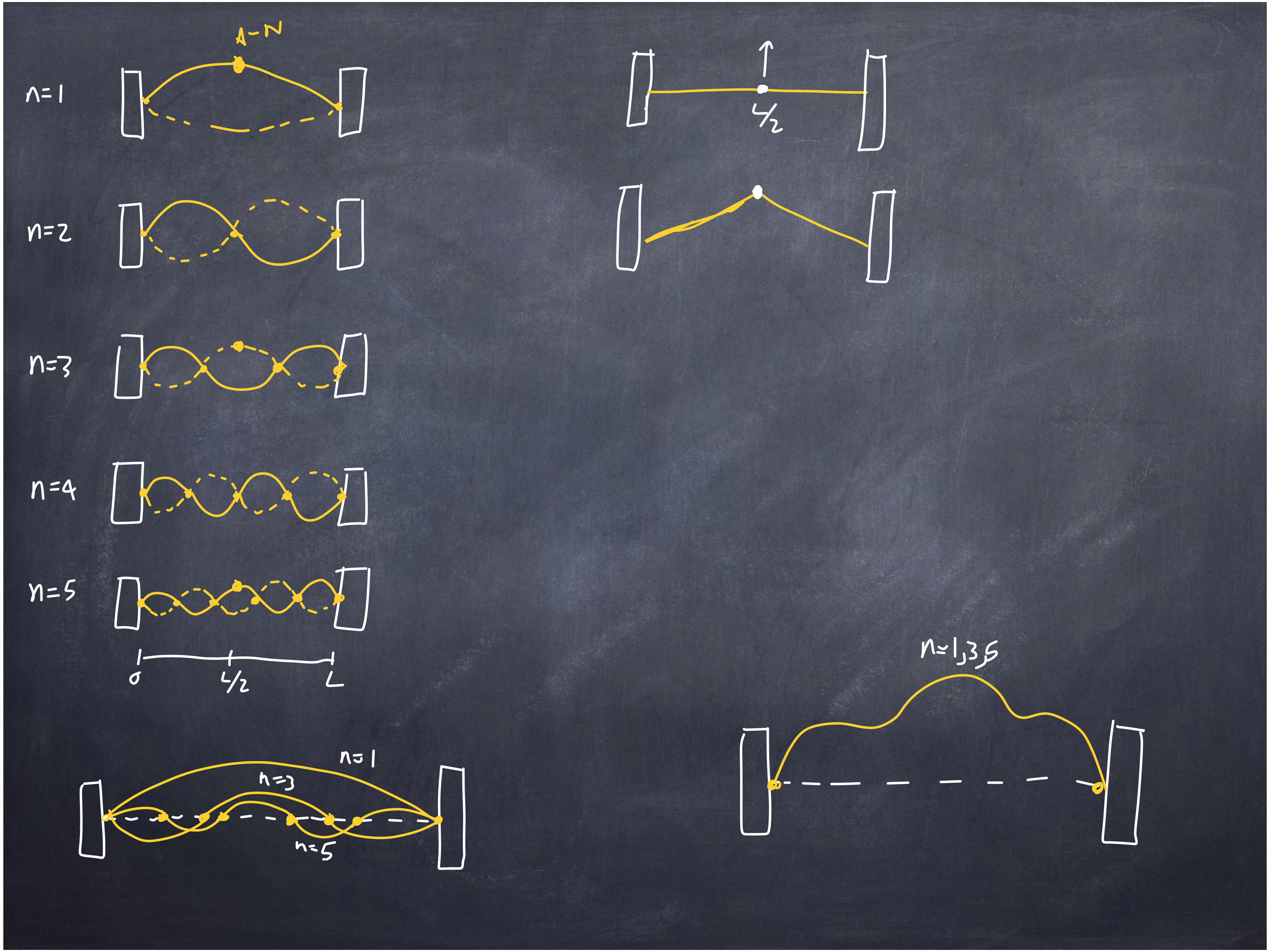
$$\omega_n = 2\pi n f_1$$

$$f_1 = \frac{v}{\lambda_1} = \frac{k_1 v}{2\pi}$$

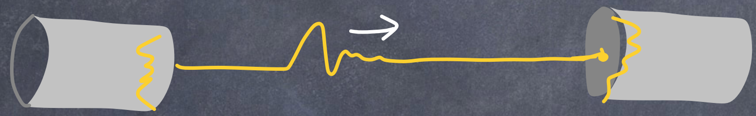
Example:
standing wave on string

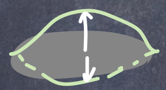
n=4

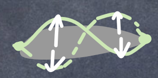
$k_4 = \frac{4\pi}{L}$, $\omega_4 = k_4 v$, $v = \sqrt{\frac{T}{\mu}}$

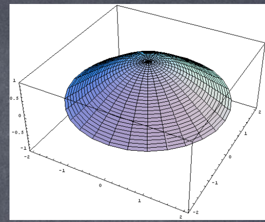

A-N
n=1
n=2
n=3
n=4
n=5
0
L/2
L
n=1
n=3
n=5
L/2
n=1,3,5

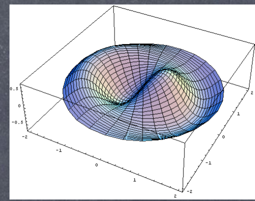

T

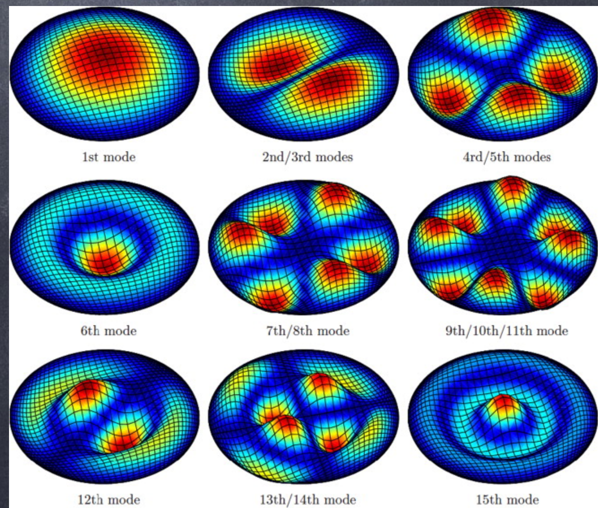






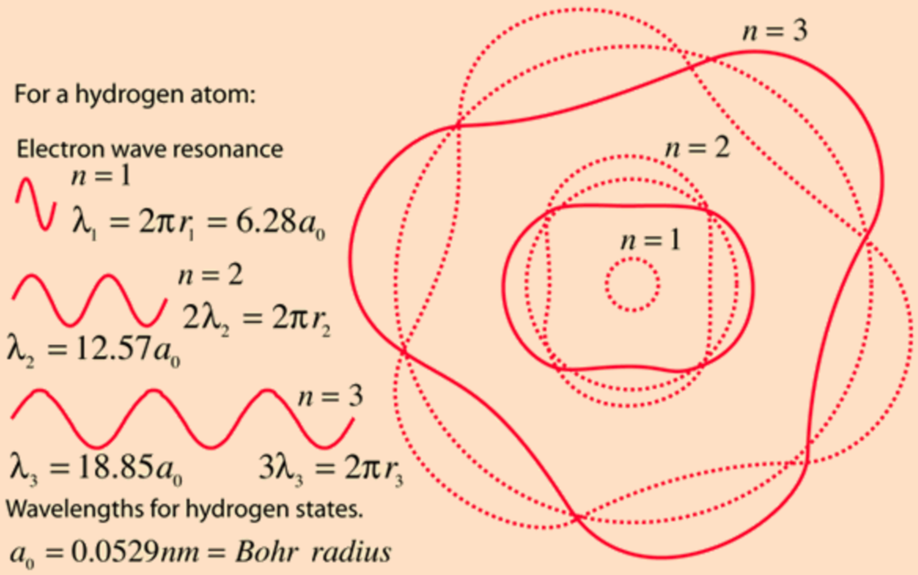





1st mode
2nd/3rd modes
4rd/5th modes
6th mode
7th/8th mode
9th/10th/11th mode
12th mode
13th/14th mode
15th mode


W 48

Wavelengths for Different States



Bohr model of the atom

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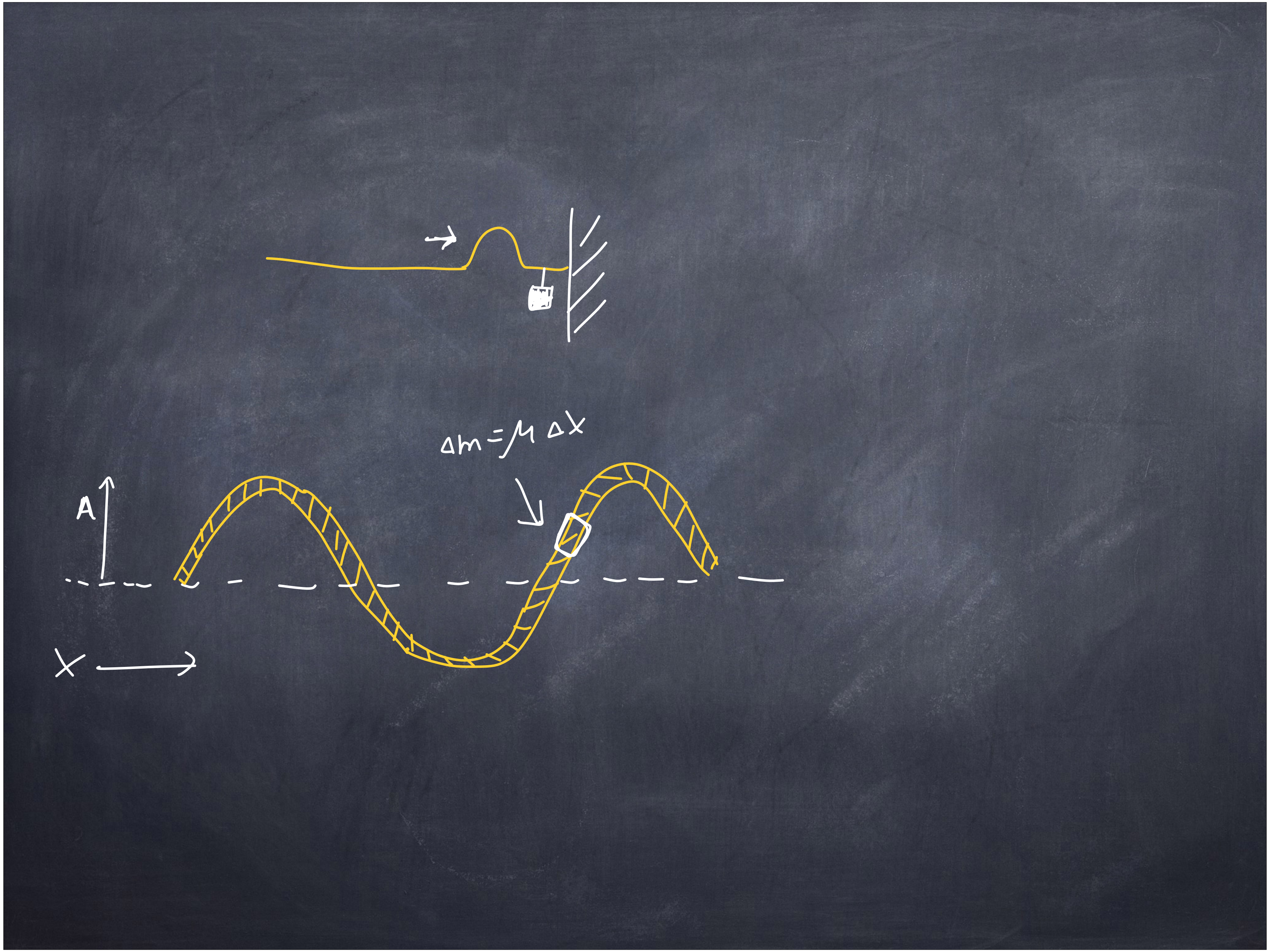
Bohr model concepts

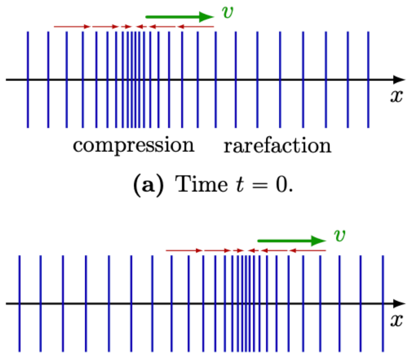
HyperPhysics***** Quantum Physics

R Nave

Go Back

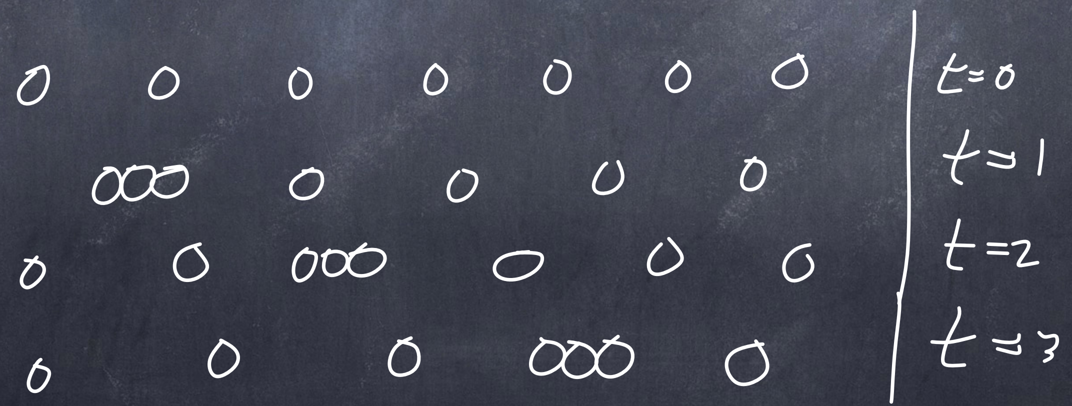


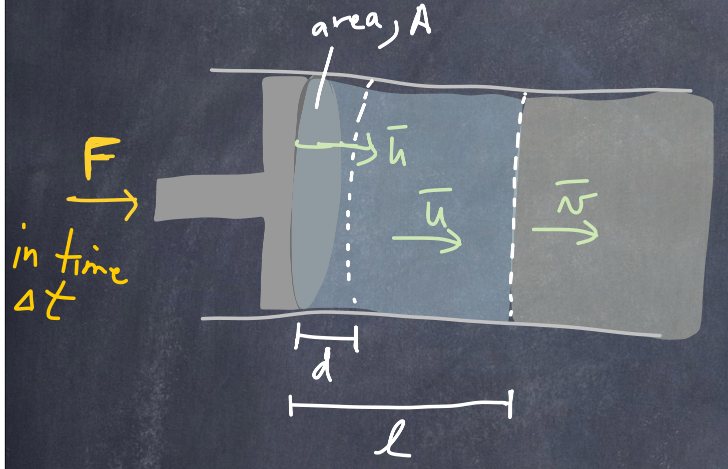
Δm = μ Δx
A
X



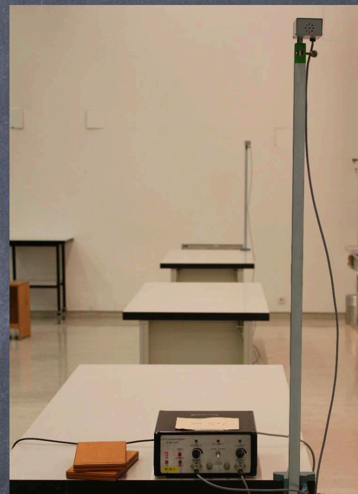
(b) Time $t = \Delta t$.

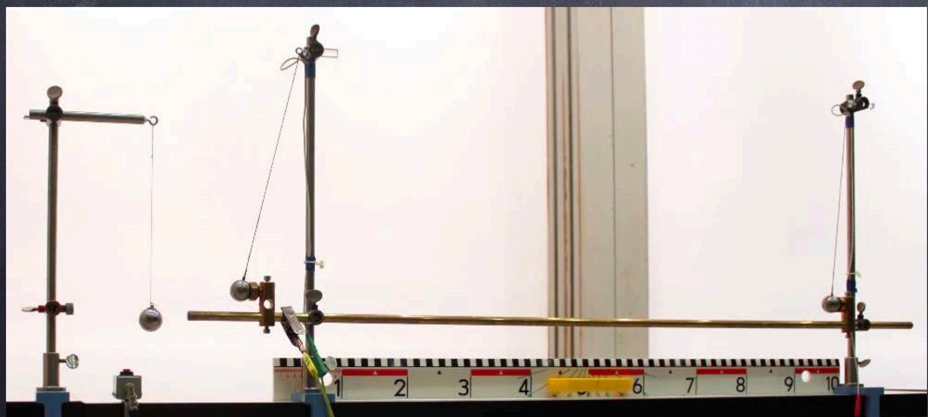
Figure 13.10: A traveling longitudinal wave is when the distortion happens along the direction of propagation, here shown as a local displacement.

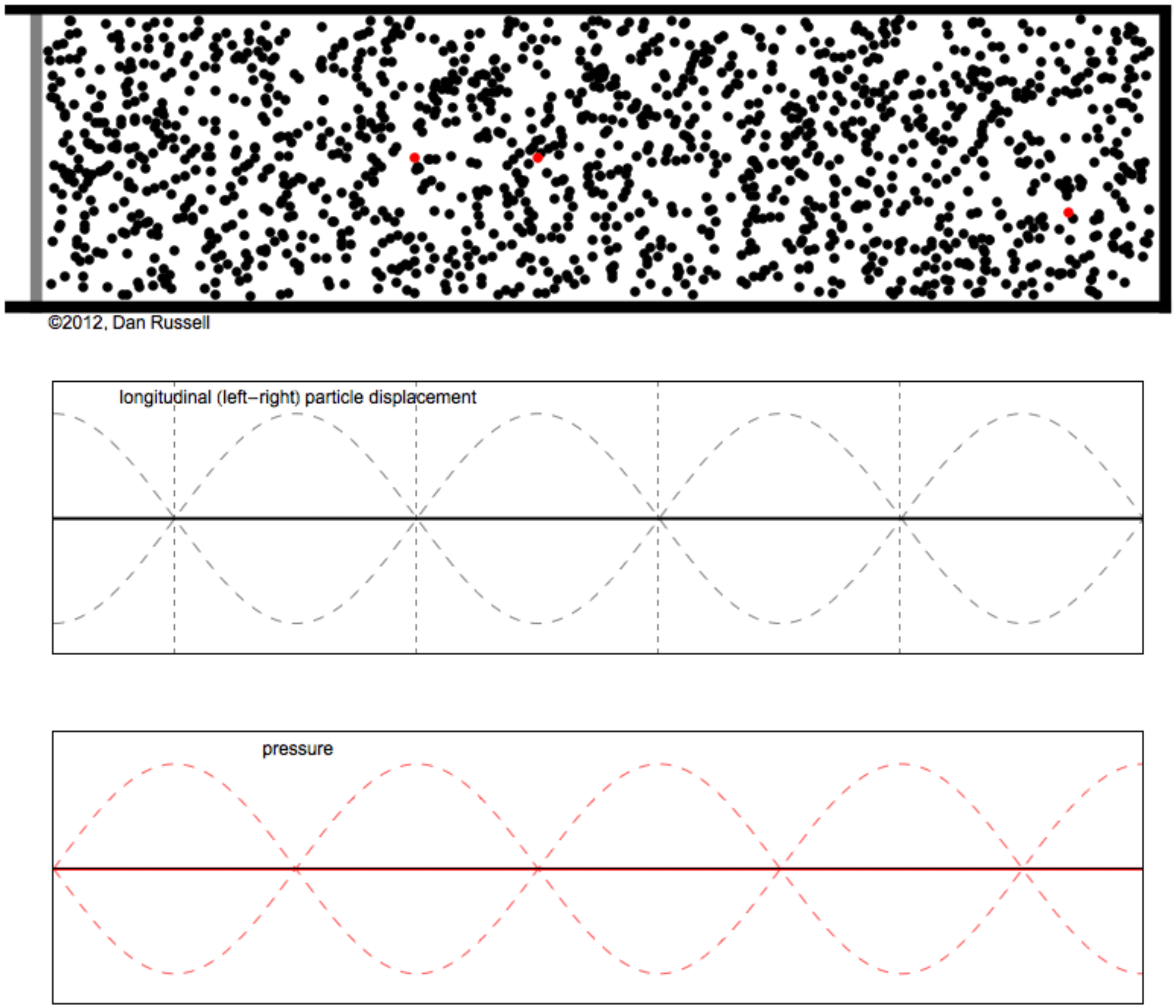




area, A
F
in time
Δt
d
ℓ






©2012, Dan Russell
longitudinal (left–right) particle displacement
pressure

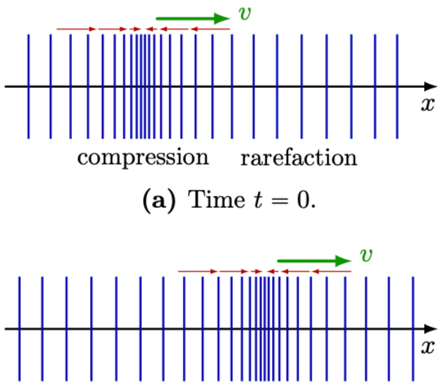


Figure 13.10: A traveling longitudinal wave is when the distortion happens along the direction of propagation, here shown as a local displacement.

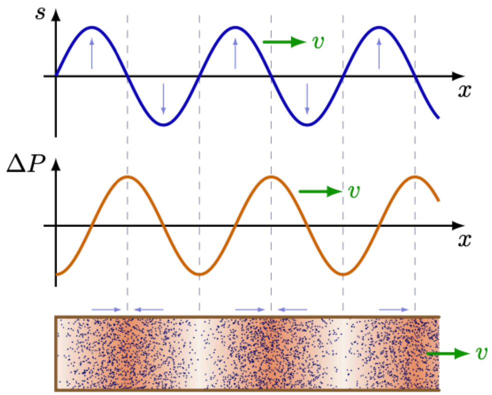
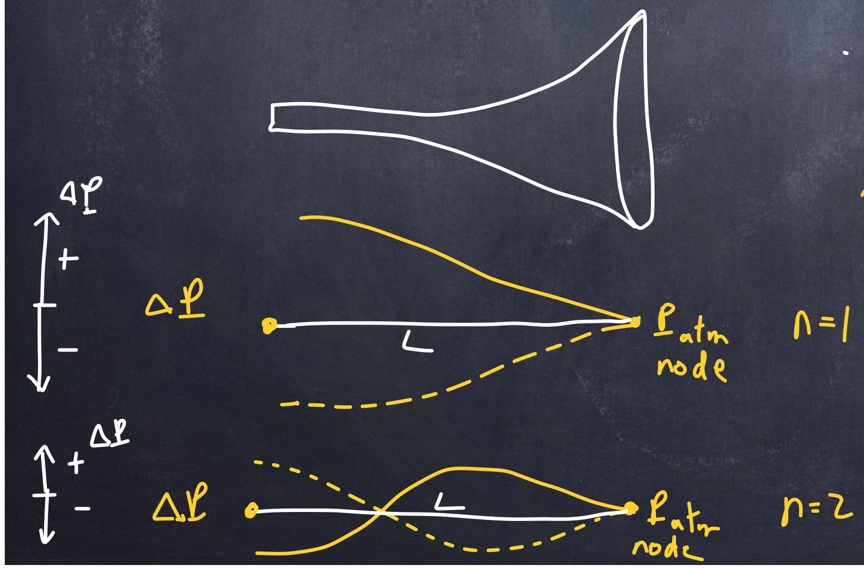
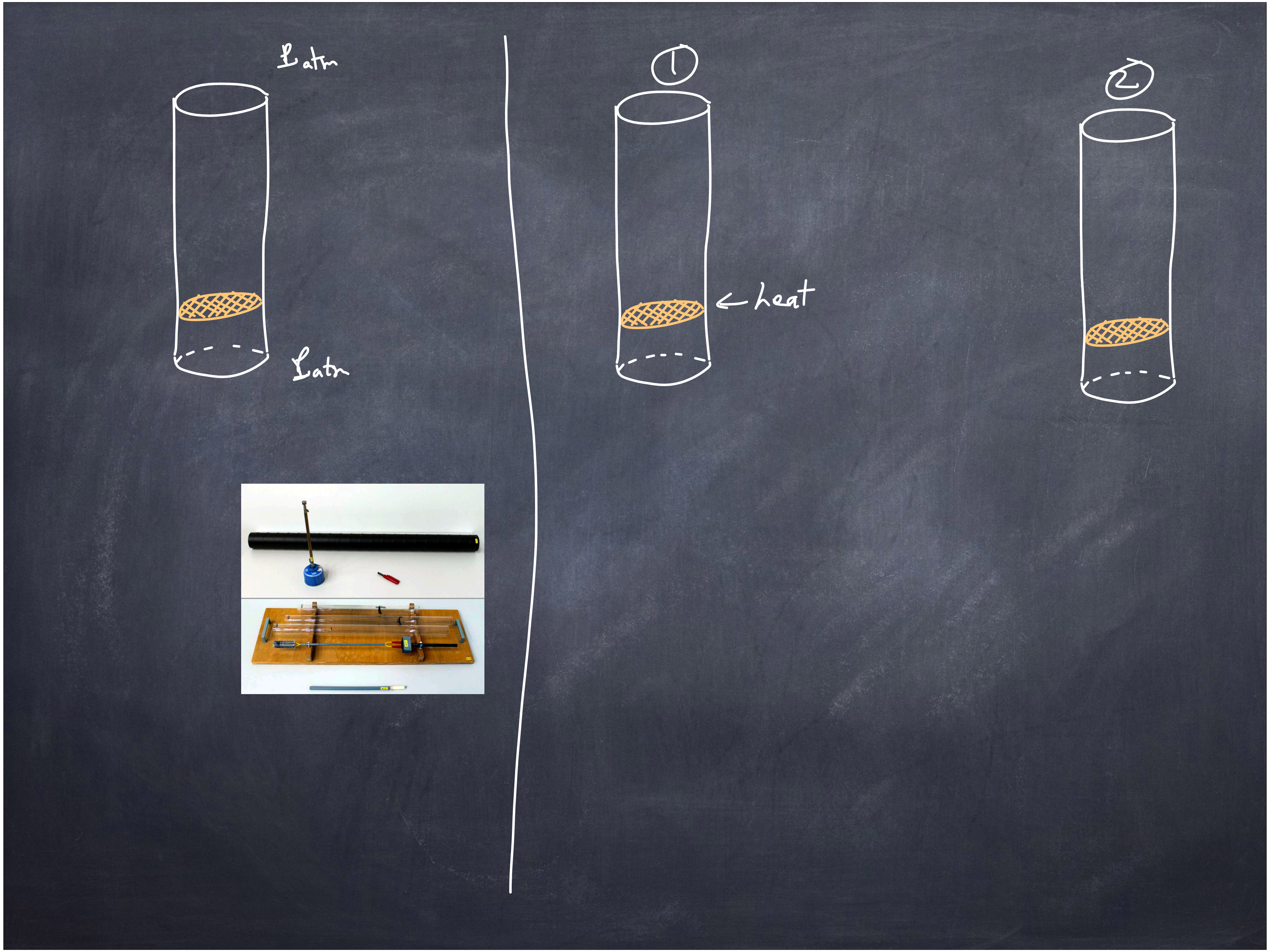
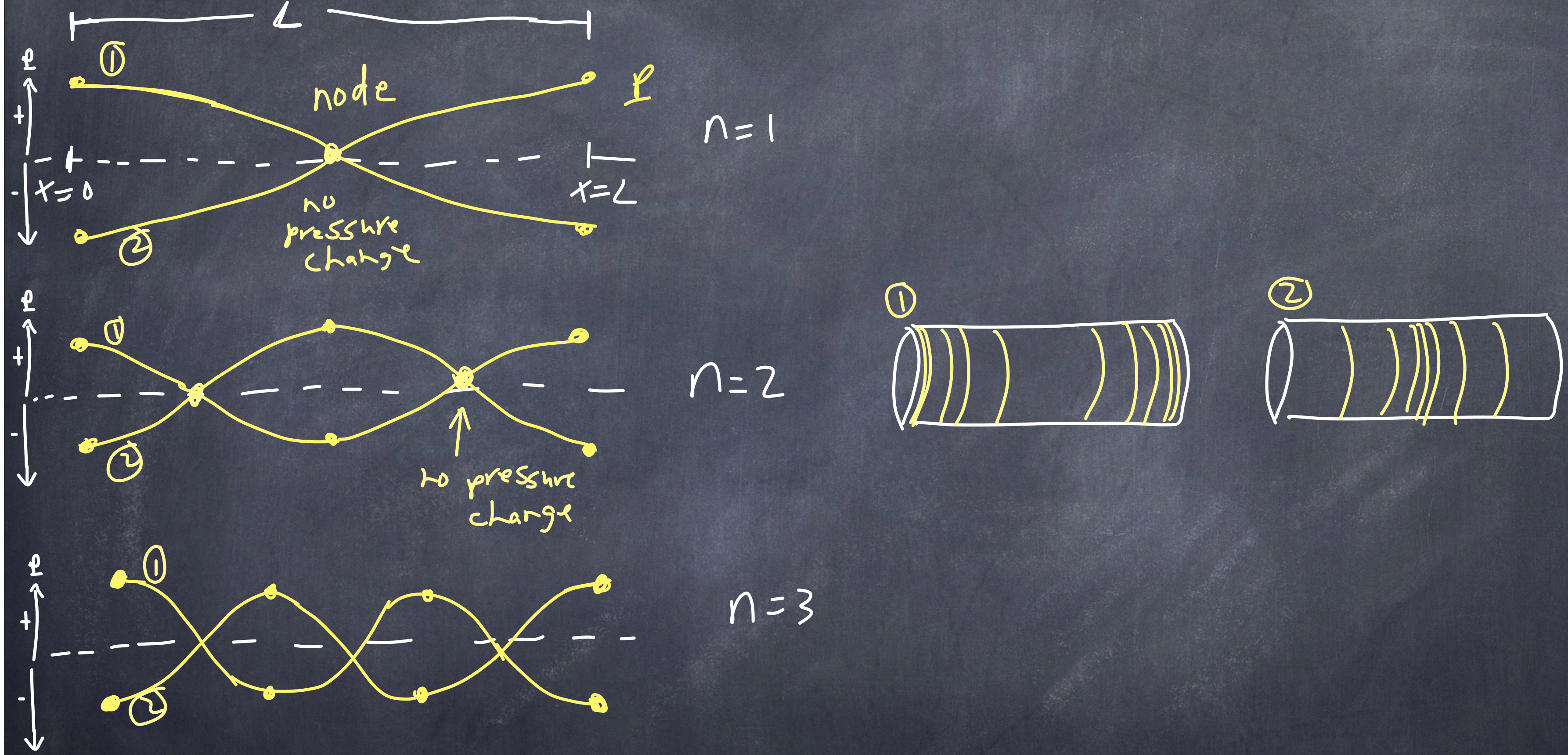


Figure 13.11: Sound wave traveling in a tube of air, shown as a local, average displacement s of air molecules in the longitudinal (x) direction (blue), and a local pressure variation ΔP (orange), 90° out of phase with s.

Alphorn



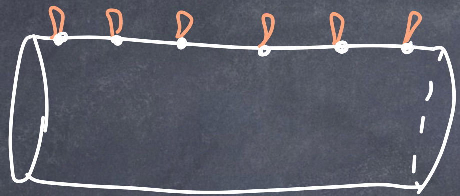

1atm
1atm
1
← heat
2

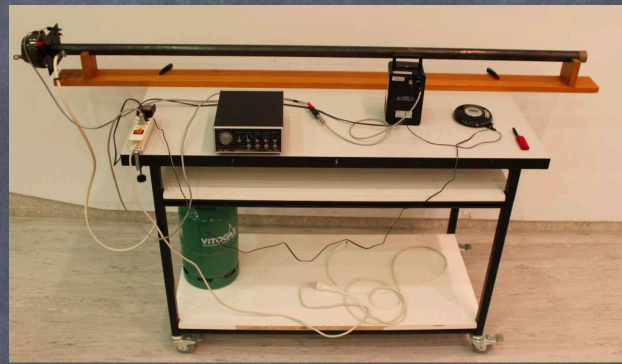


L
ℓ
1
node
n=1
x=0
x=L
no pressure change
2
n=2
no pressure change
n=3

Ruben's flame tube

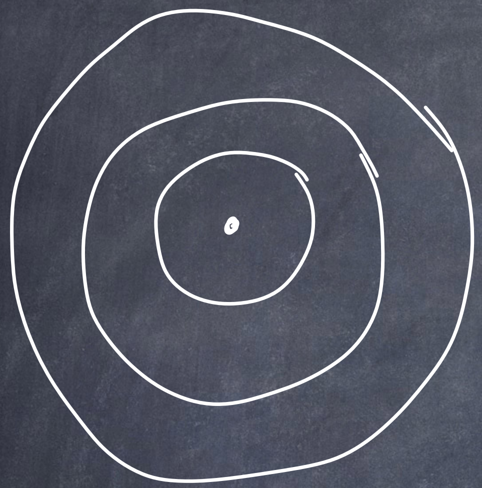
①

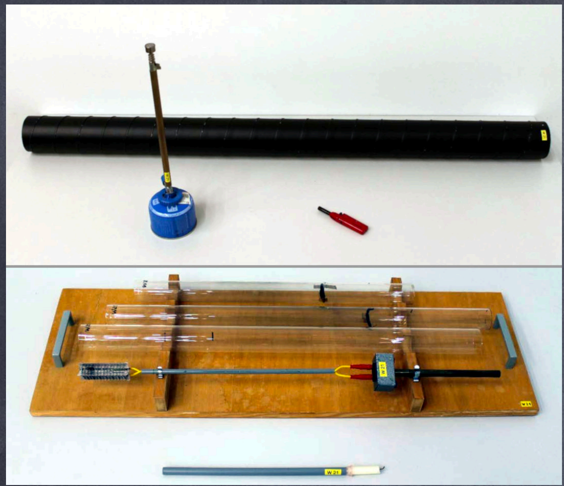




n=1

n=2





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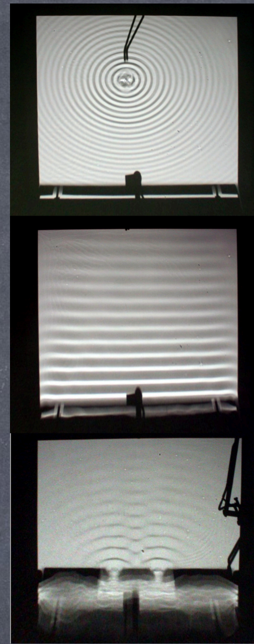
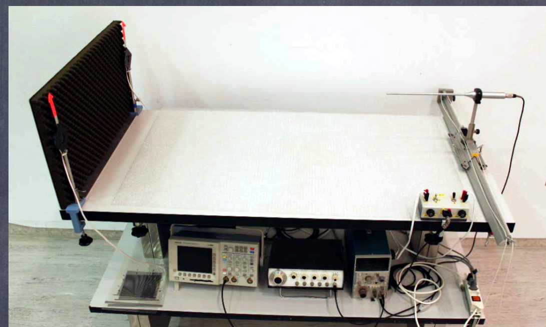
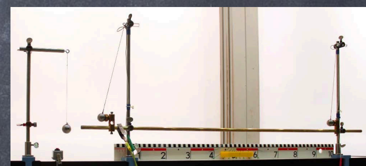


W108



W110

W34



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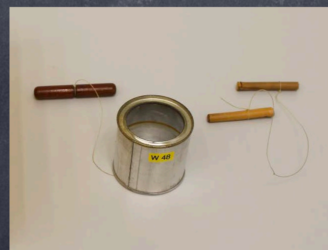
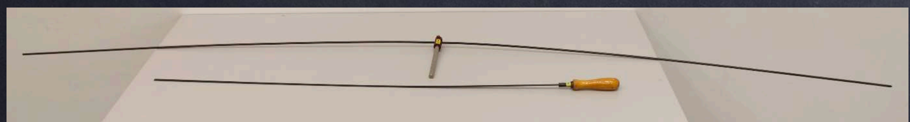


W48

W33



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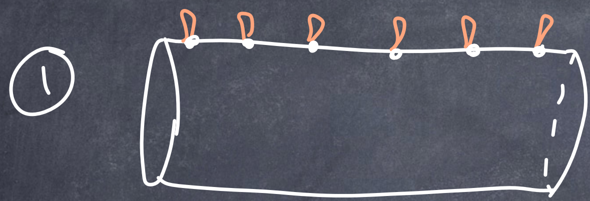
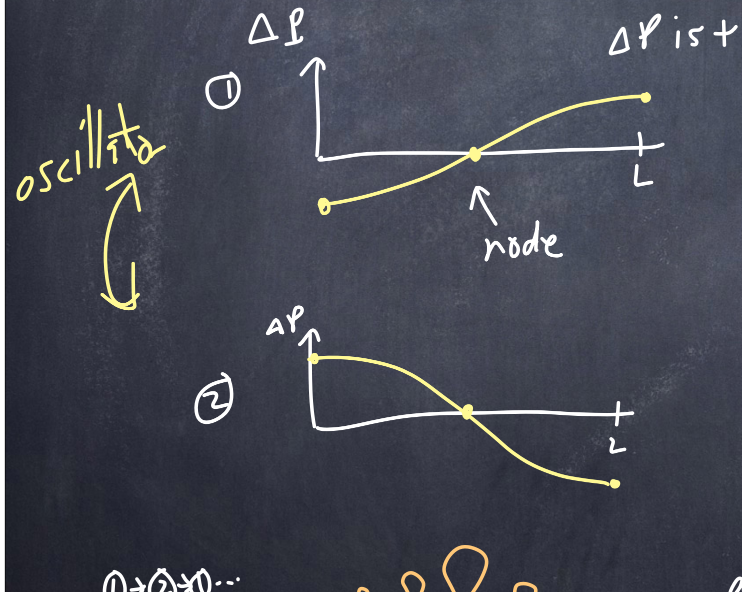
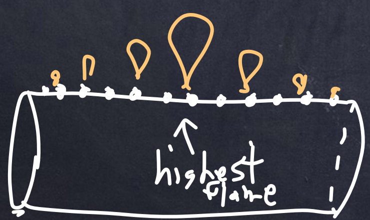
Ruben's flame tube

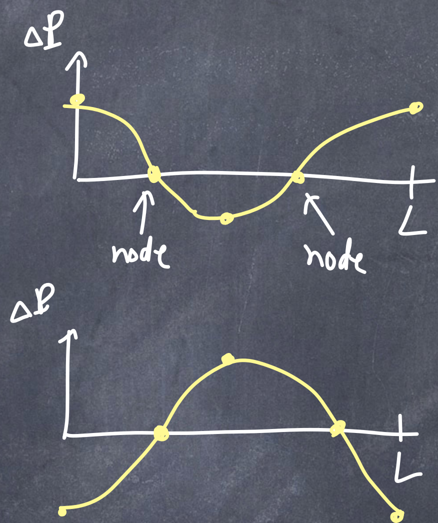


n = 1





n = 2



flame is higher at node because ΔP is smaller than P_{atm}

(see next page)

For quiet sounds, ΔP of the gas < P of the gas

From Bernoulli's equation, gas flow is proportional to square root of the pressure difference between inside + outside tube.

$$\text{flow} \sim \sqrt{P_{inside} - P_{outside}}$$

(The flow of gas out of the pipe)

$\Delta P_{maximal}$, anti-nodes produce lower flames (flow rate is lower)

$\Delta P = 0$, nodes, flow rate is higher

Part of the cycle, pressure is higher than average but part is lower. On average

This is why pressure is higher at nodes:

$\sqrt{\text{Pressure difference at anti-nodes}} < \sqrt{\text{Pressure}}$ at nodes.