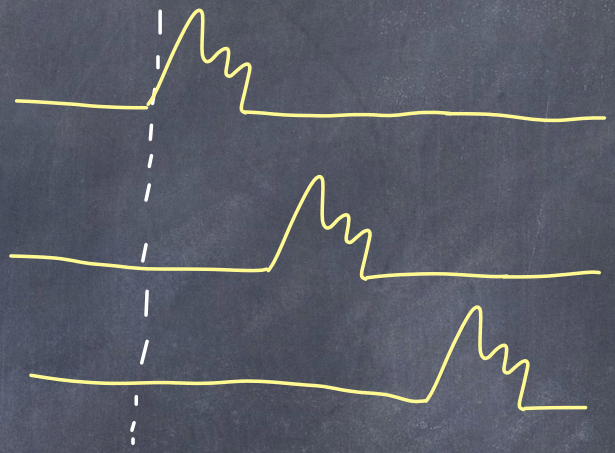
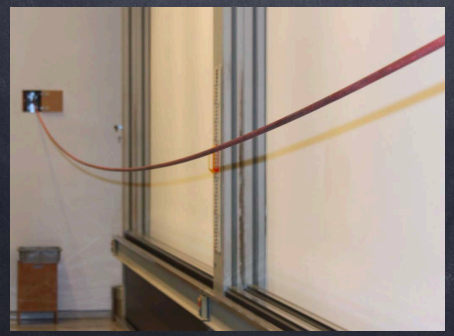
PHY117 HS2023

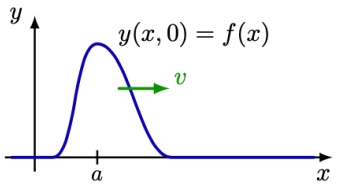
Week 11, Lecture 2
Nov. 29th, 2023
Prof. Ben Kilminster

WAVES

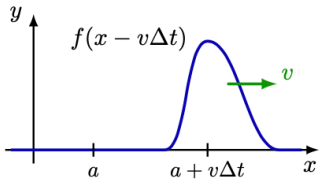
WAVES:





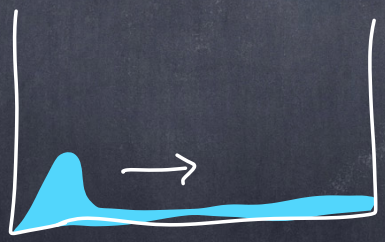


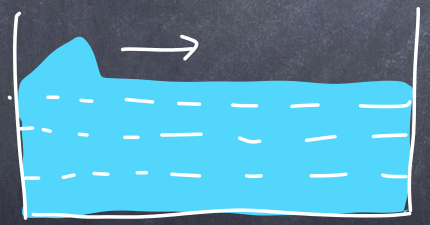
(a) Shape of wave at time $t = 0$ can be some function f in space variable x.



(b) The shape moved by a distance $v\Delta t$ at time $t = \Delta t$.

Figure 13.1: A transverse wave is a traveling wave that distorts a medium in the direction perpendicular to the direction of propagation.

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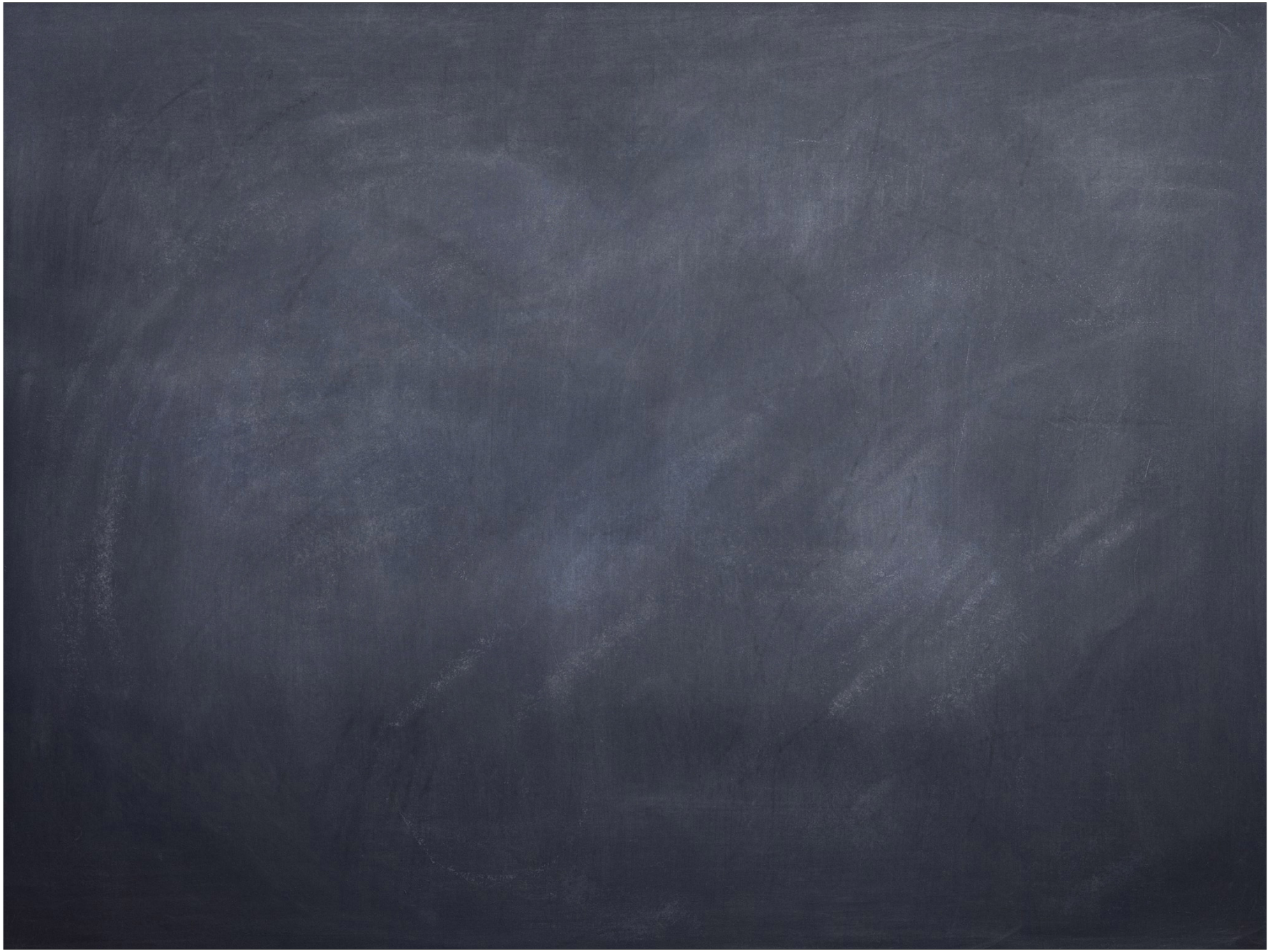
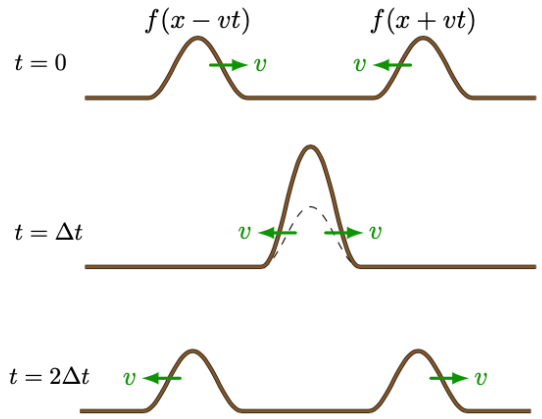
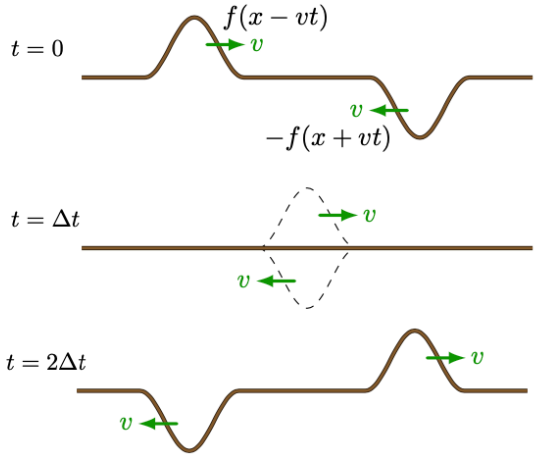


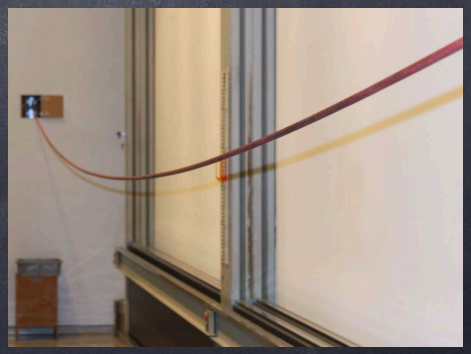


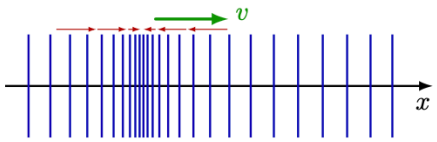
(a) Constructive interference happens when two oppositely waves meet on a string.



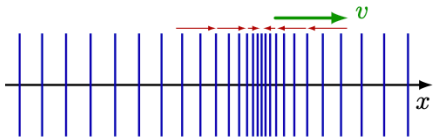
(b) Destructive interference. If the waves are the same but for a sign, they cancel completely.

Figure 13.5: Superposition between two oppositely travelling waves in the same medium is a simple linear sum.



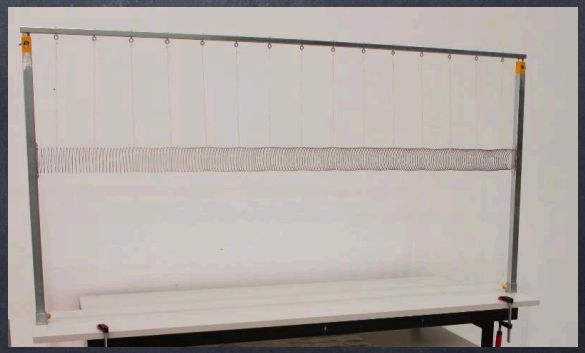


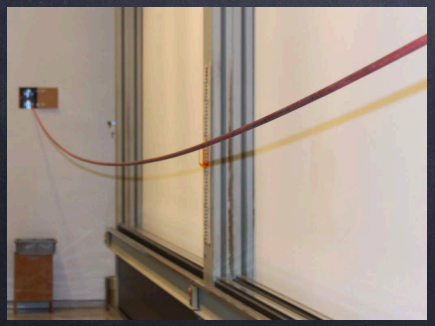
(a) Time $t = 0$.

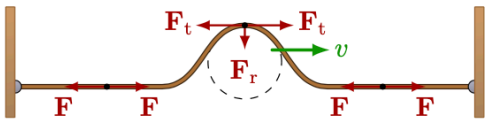


(b) Time $t = \Delta t$.

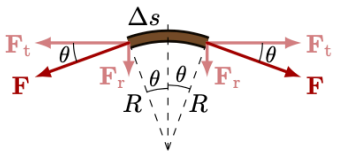
Figure 13.10: A traveling longitudinal wave is when the distortion happens along the direction of propagation, here shown as a local displacement.





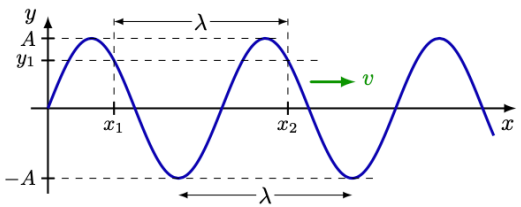


(a) Forces on a string. All across the string, there is a constant tension $\mathbf{F}$.

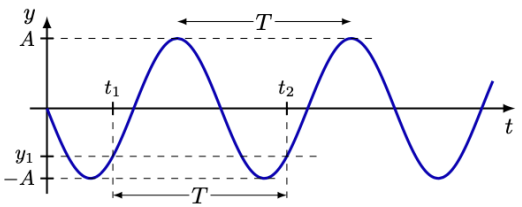


(b) Small segment of length Δs experiences a tension $\mathbf{F}$ on either side.

Figure 13.3: The tension in a string is increased due to a disturbance.

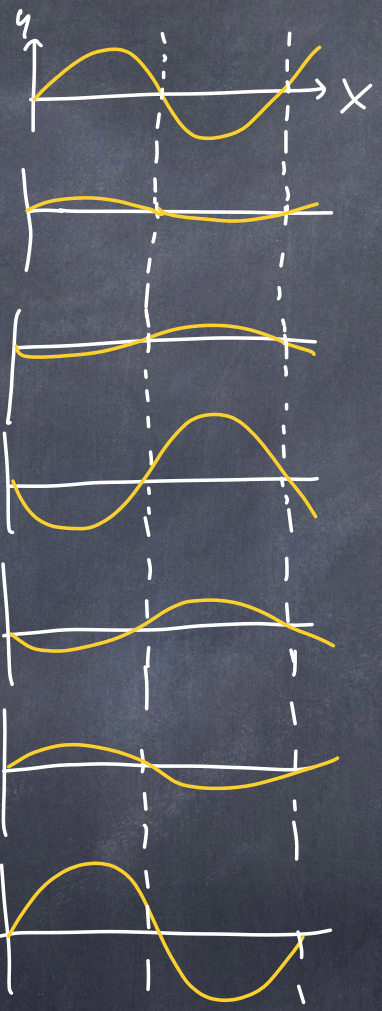


(a) Whole wave in space at time $t = 0$, given by $y(x, 0) = A\sin(kx)$.



(b) Local disturbance at position $x = 0$, given by $y(0, t) = -A\sin(\omega t)$.

Figure 13.2: A space and time slice of a travelling sine wave $y(x, t) = A\sin(kx - \omega t)$.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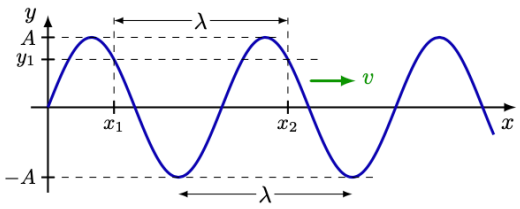
x



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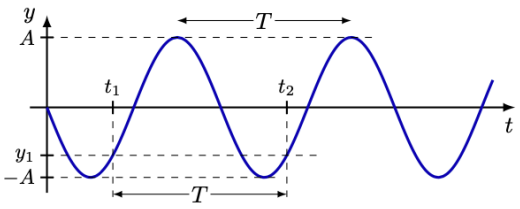

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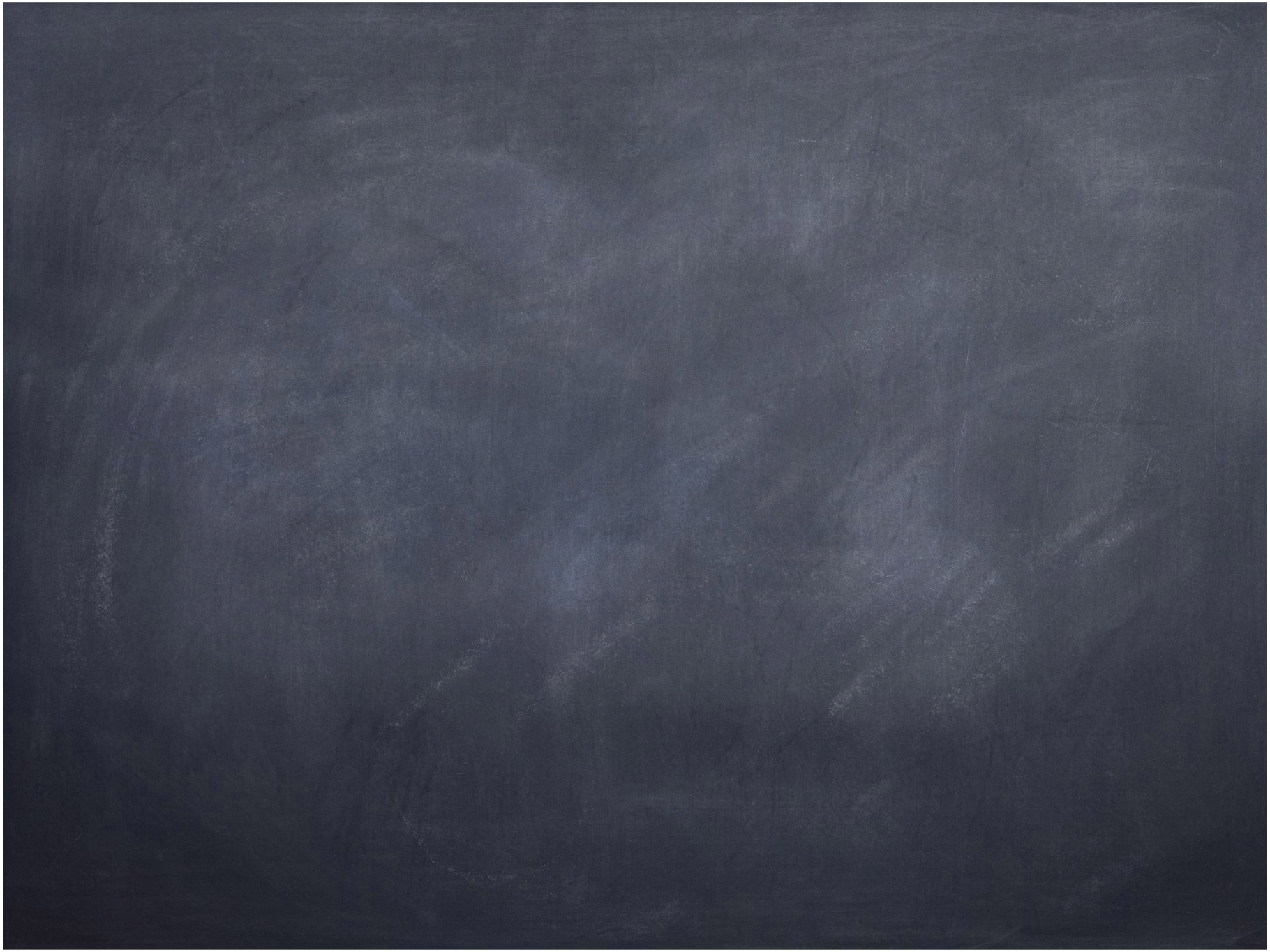
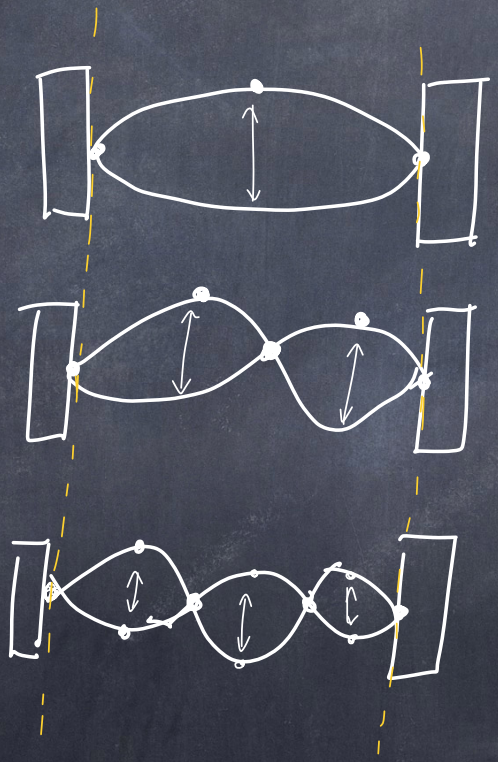
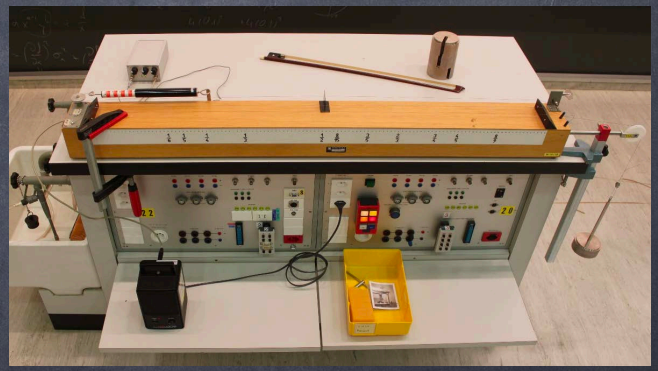
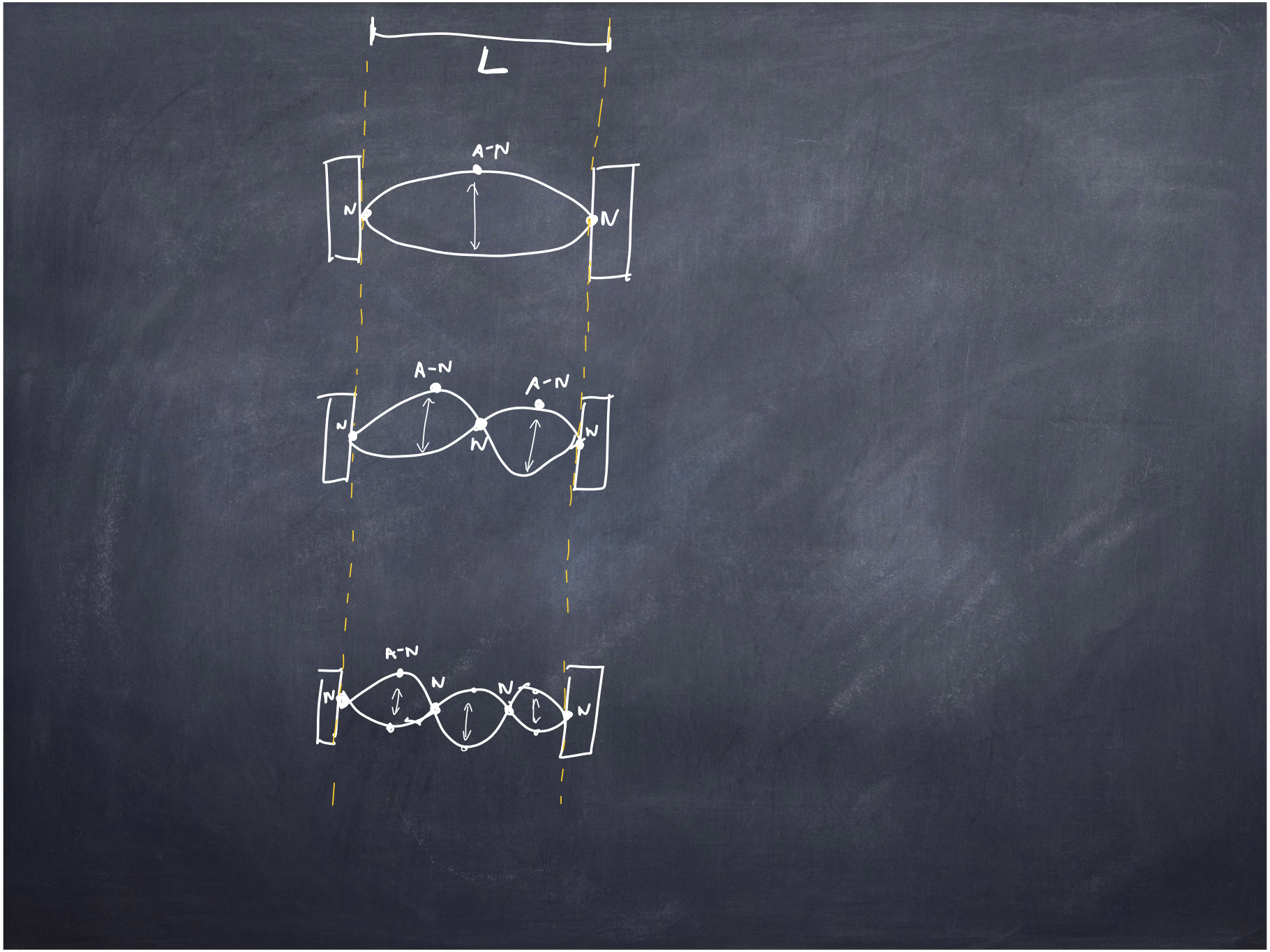


13.2 Wave equation



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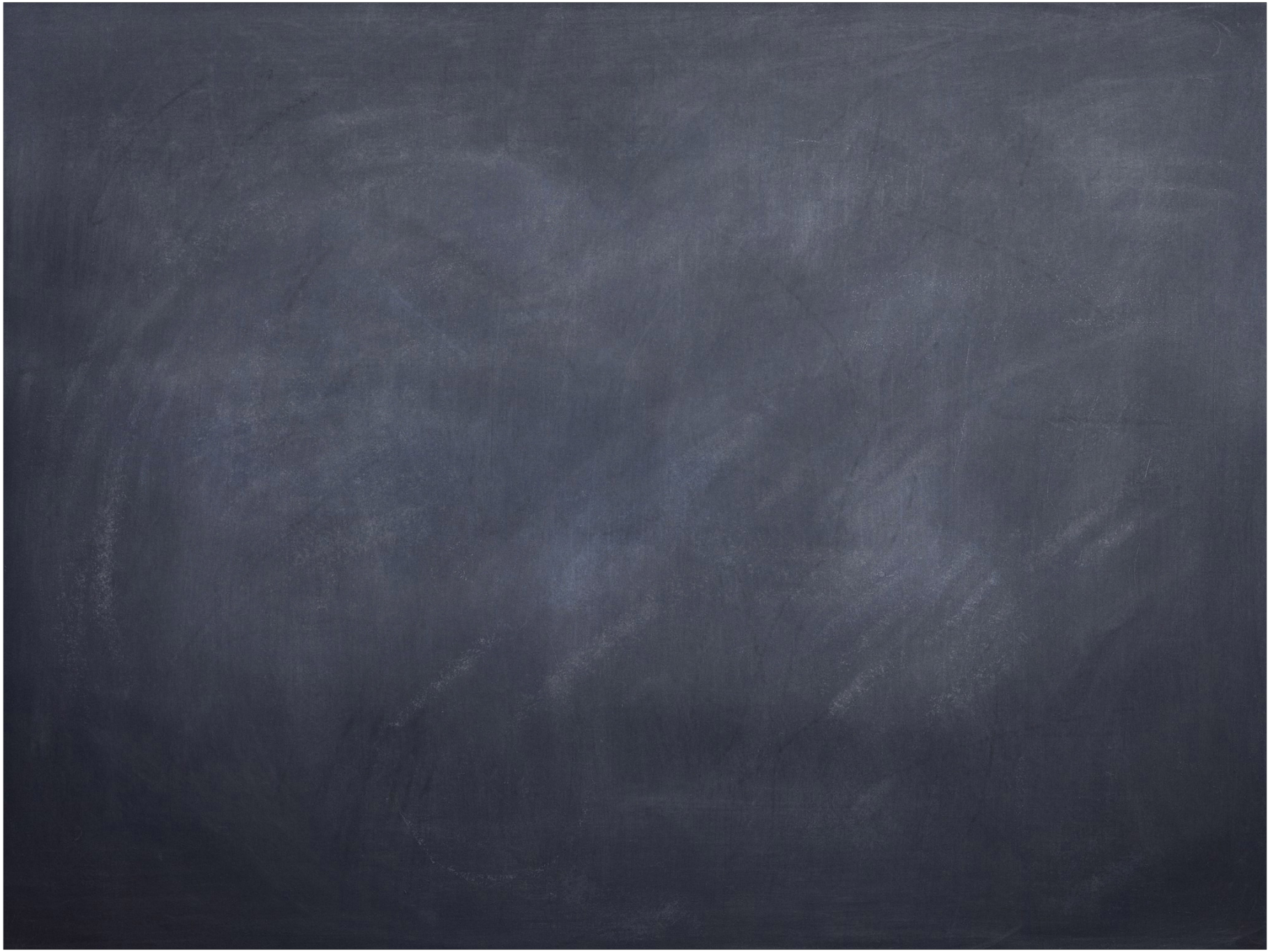
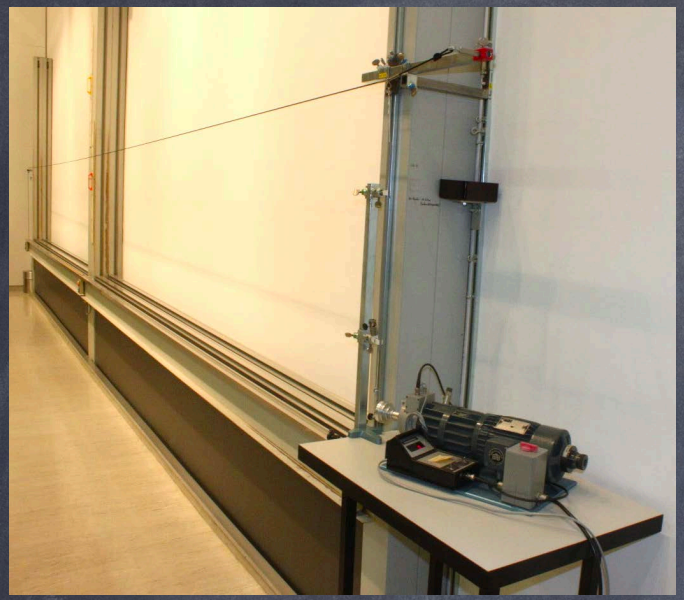
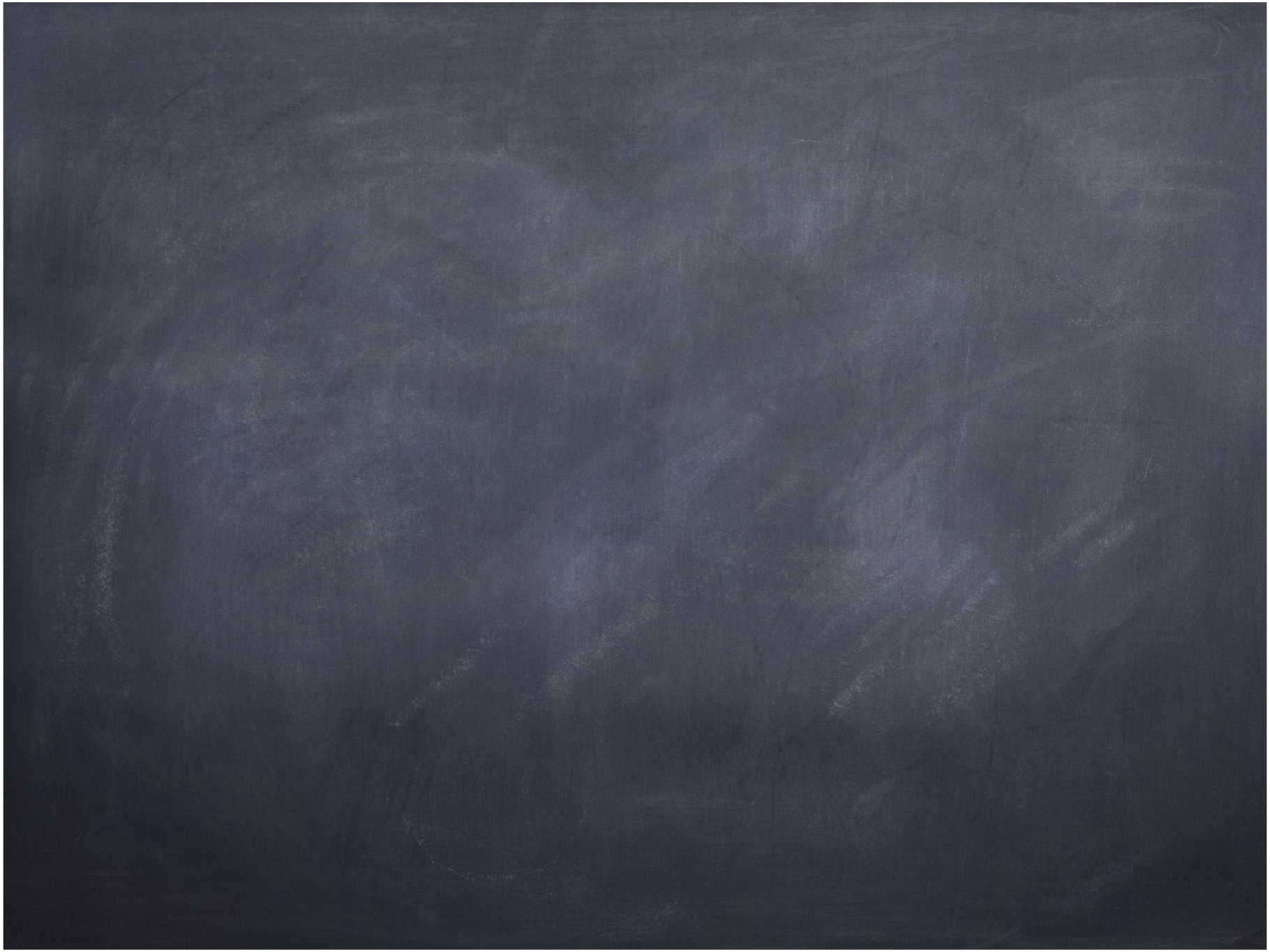
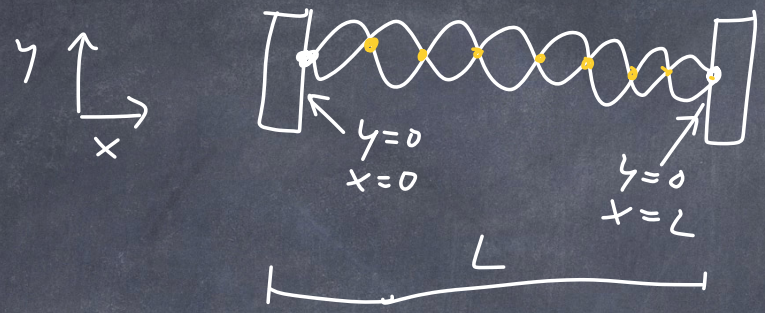
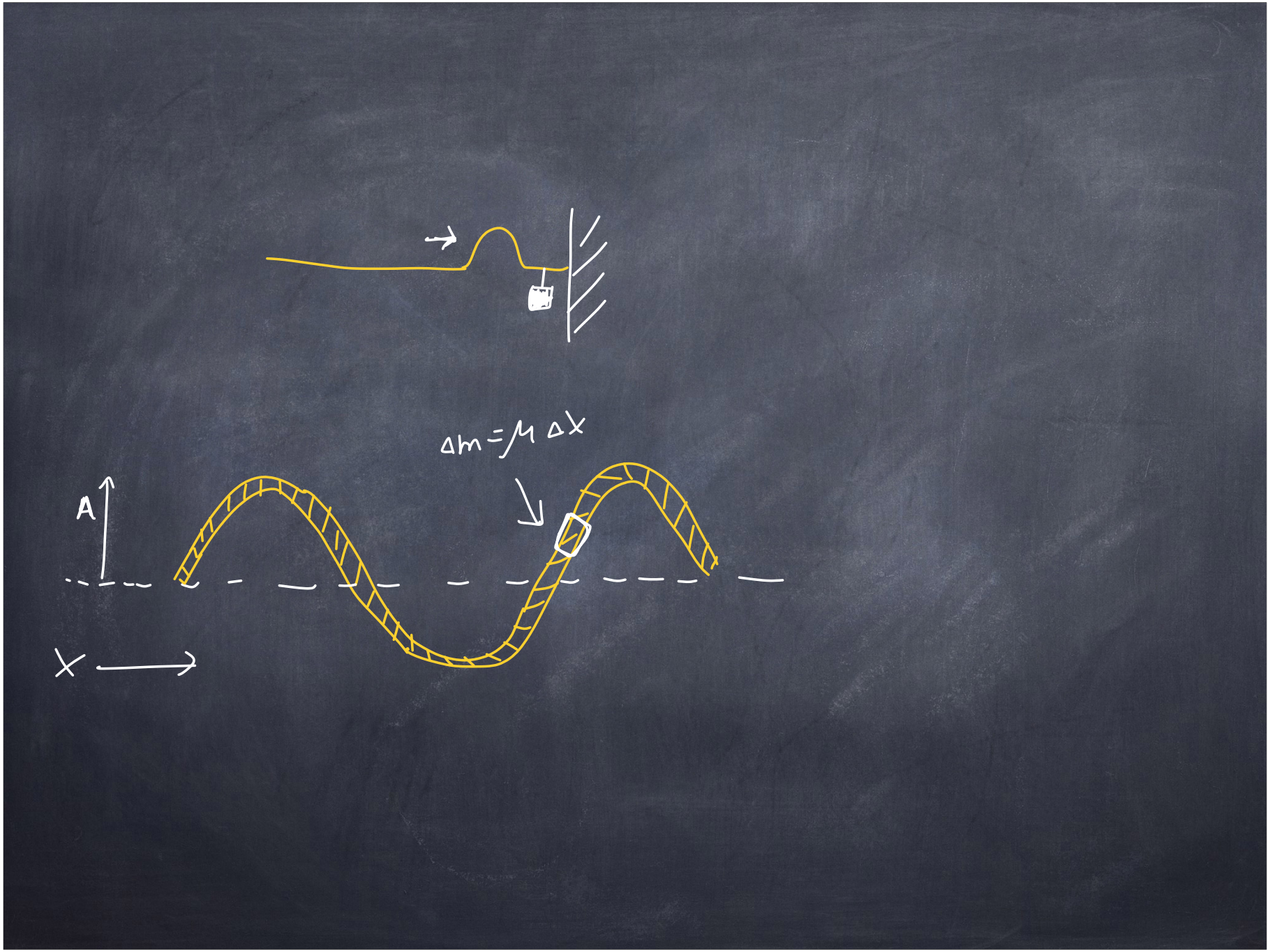
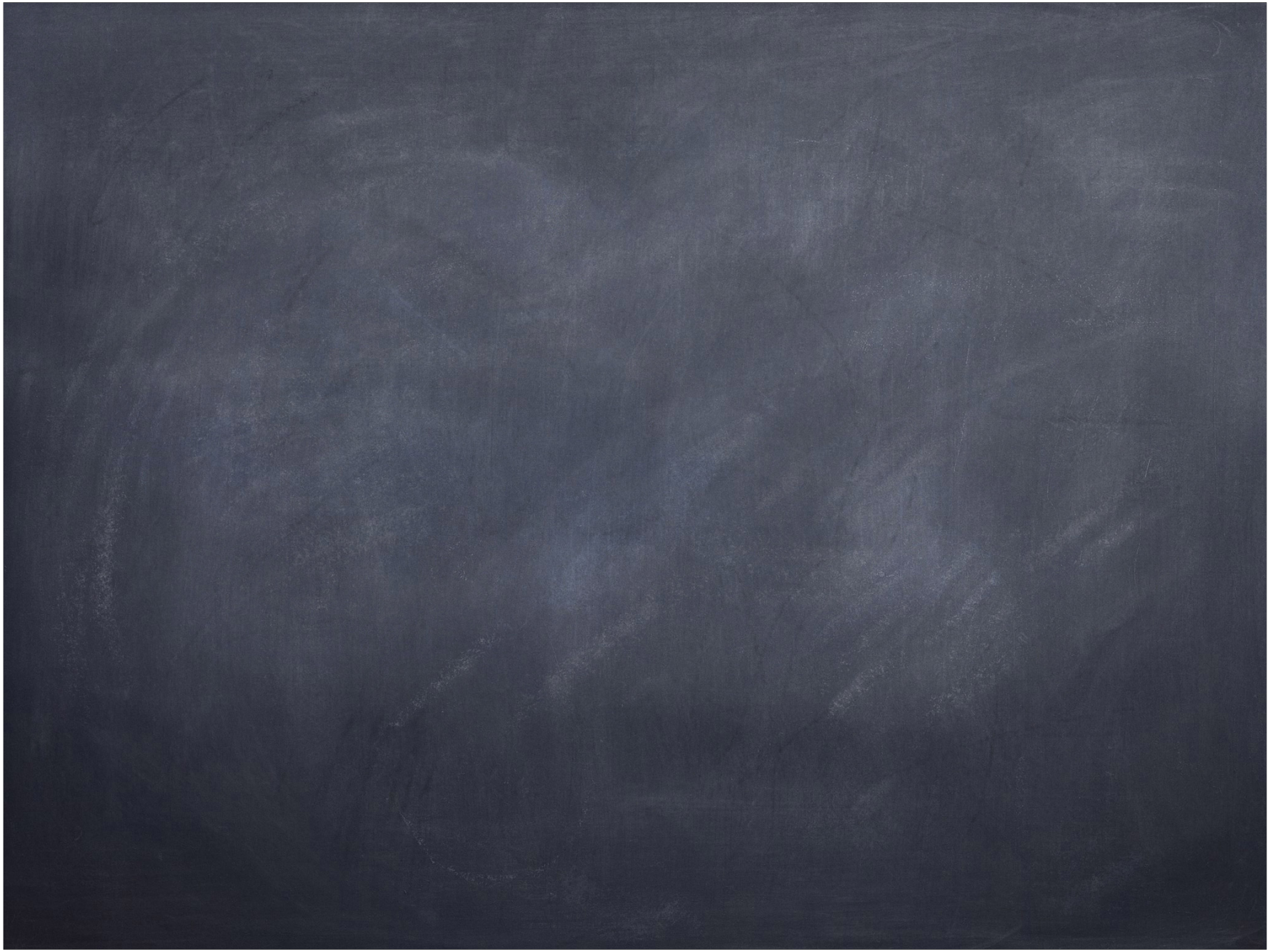


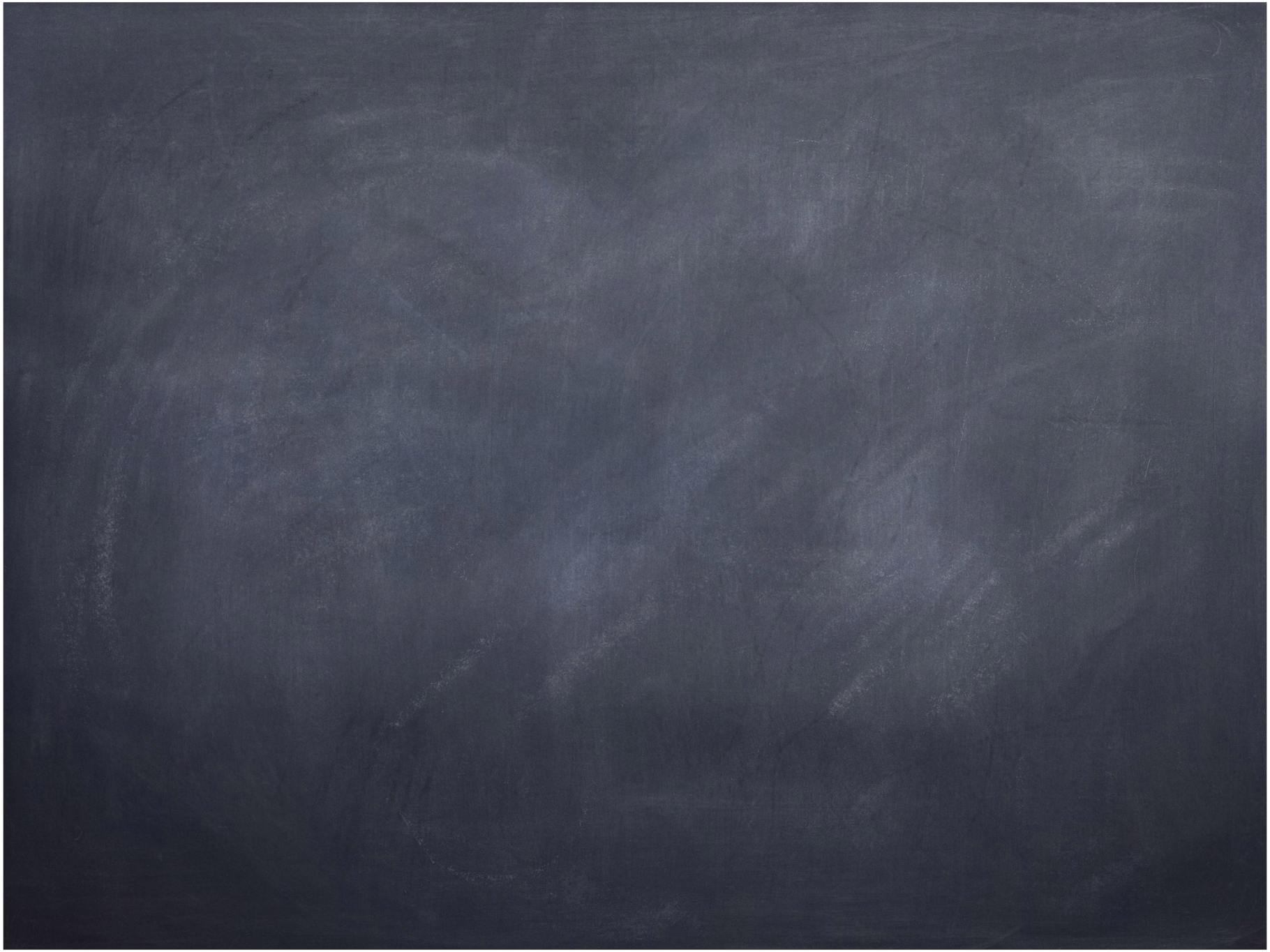


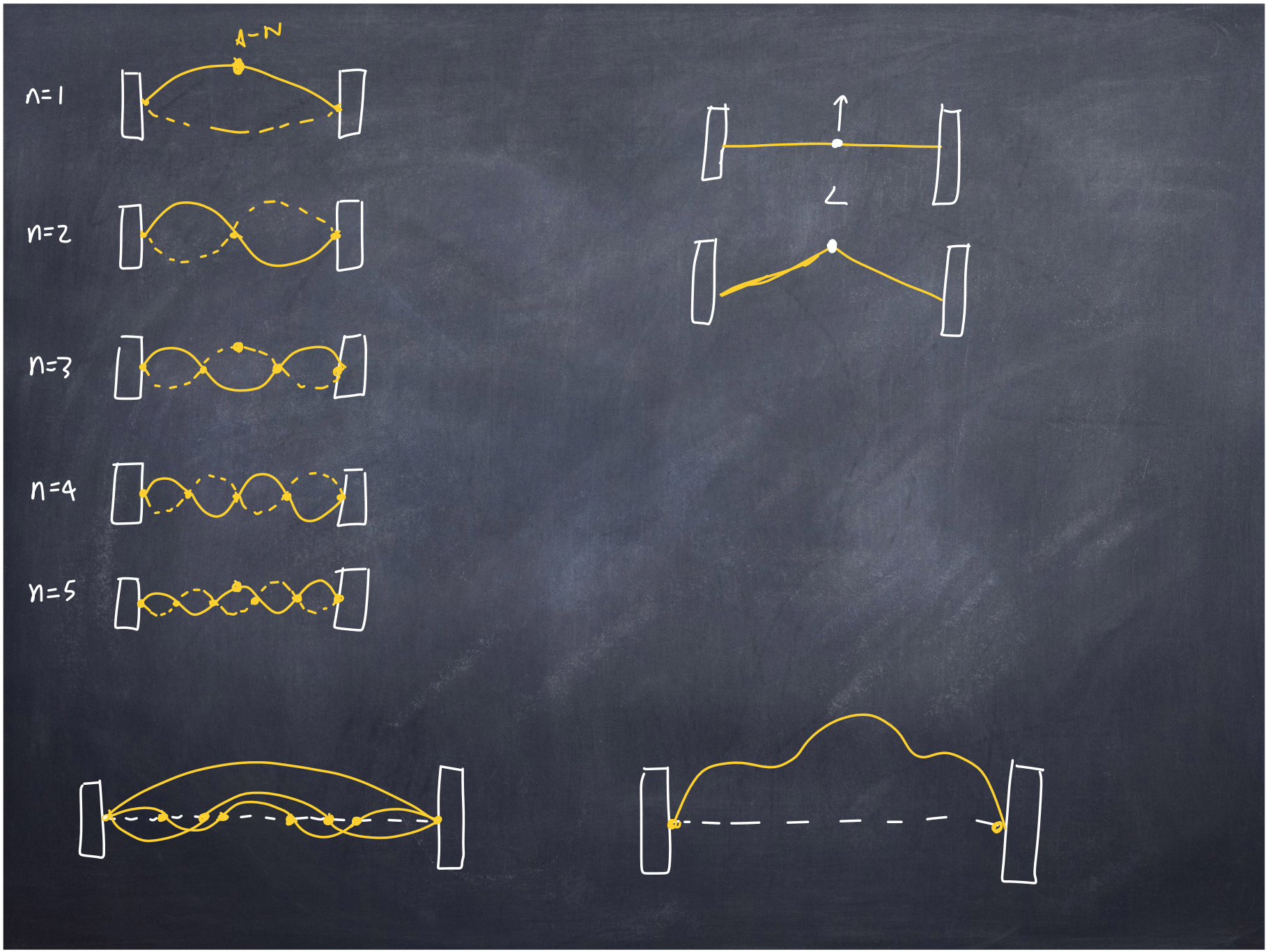



y
x
y=0
x=0
y=0
x=L
L


Δm = μ Δx
A
x






A-N
n=1
n=2
n=3
n=4
n=5
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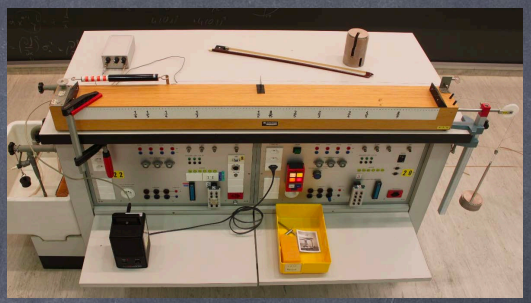

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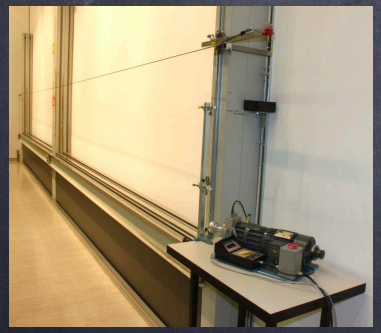

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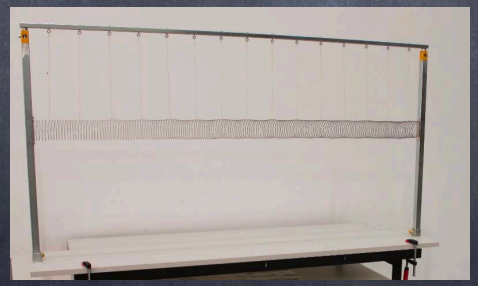

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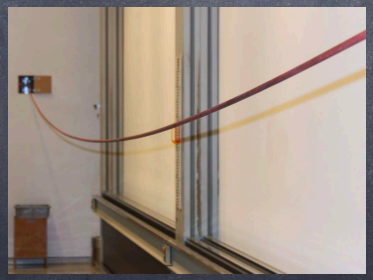

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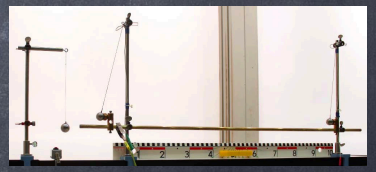

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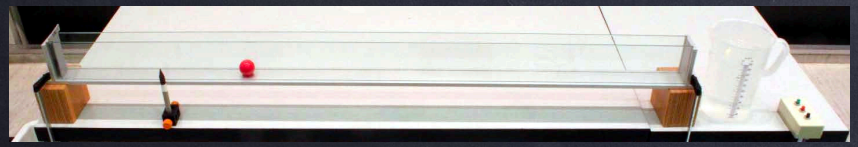

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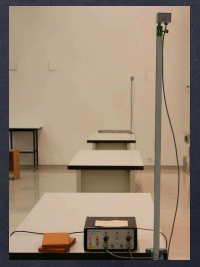

W33

we define 2 coordinate systems (or rest frames):

S: not moving

S': moving with same velocity as wave

S' has velocity v

$y' = y$

$x' = x - vt$

So we see that we can describe our wave in the S Frame by transforming its shape back to time $t=0$: $y'(x',t) = y(x-vt)$ wave function for wave moving to the right