Lecture 02: 01/18/2024

- Announcements
  Recitation – That assessment thing
  Clickers – Next Thursday
  Homeworks were extended (online Tues/Written Thurs)

- Waves
  - T, f, omega, lambda, k
  - Worked problems
  - Standing waves

Getting to know you

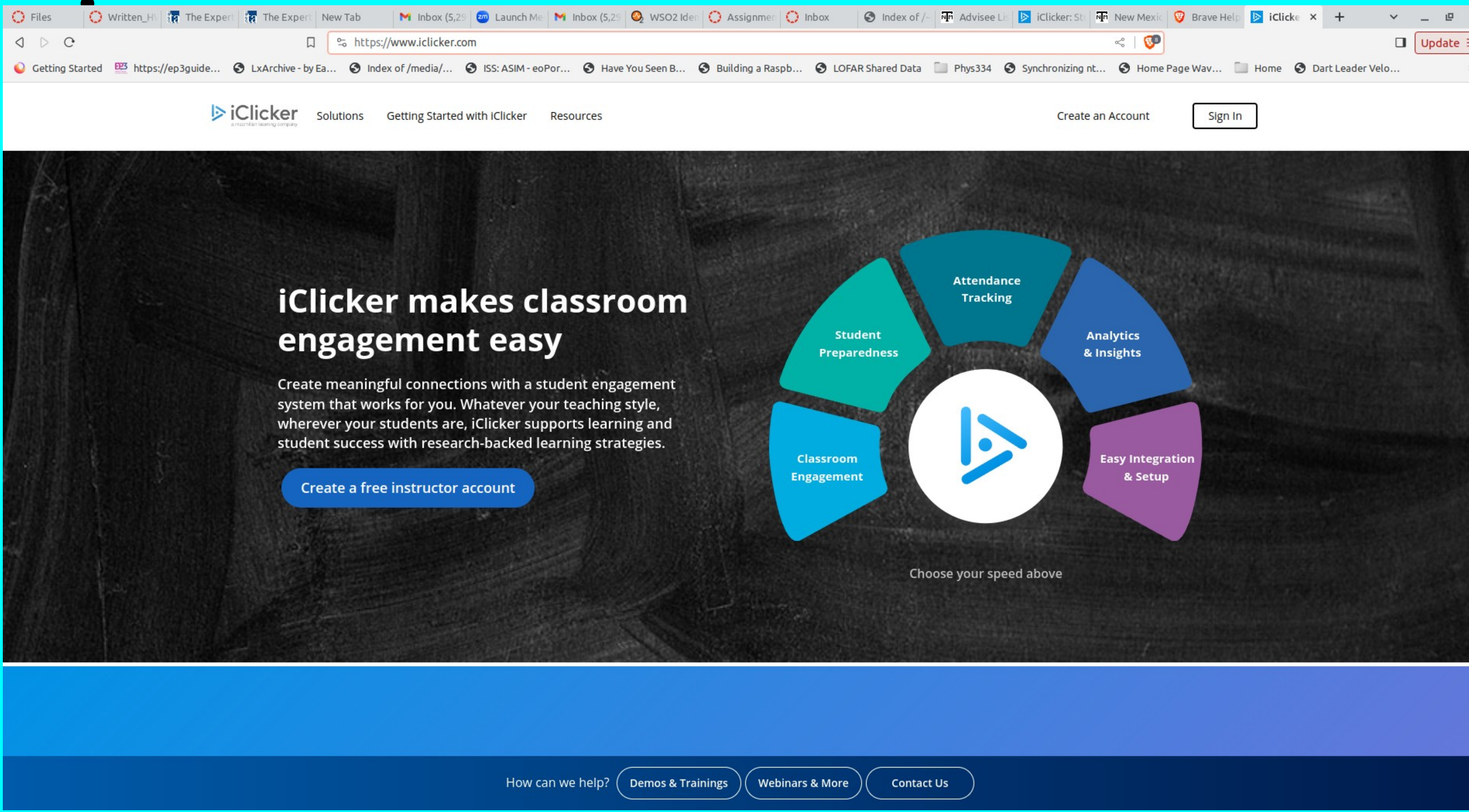
- Show us the formula and explain it
- Teach us about circuits and electricity
- Ask us about pets, favorite food and our backgrounds
- I'm a little nervous about the workload
- I enjoy solving difficult problems (eventually)
- I like to help people
- Don't forget to explain a variable
- I like group work / I don't like group work
- Give examples
- Give more examples
- Give lots of examples
- Ask about the largest animal we can take in a fight

Text

- The text is wordy, but backs up the lecture
- The text does derivations, and I will (mostly) not.

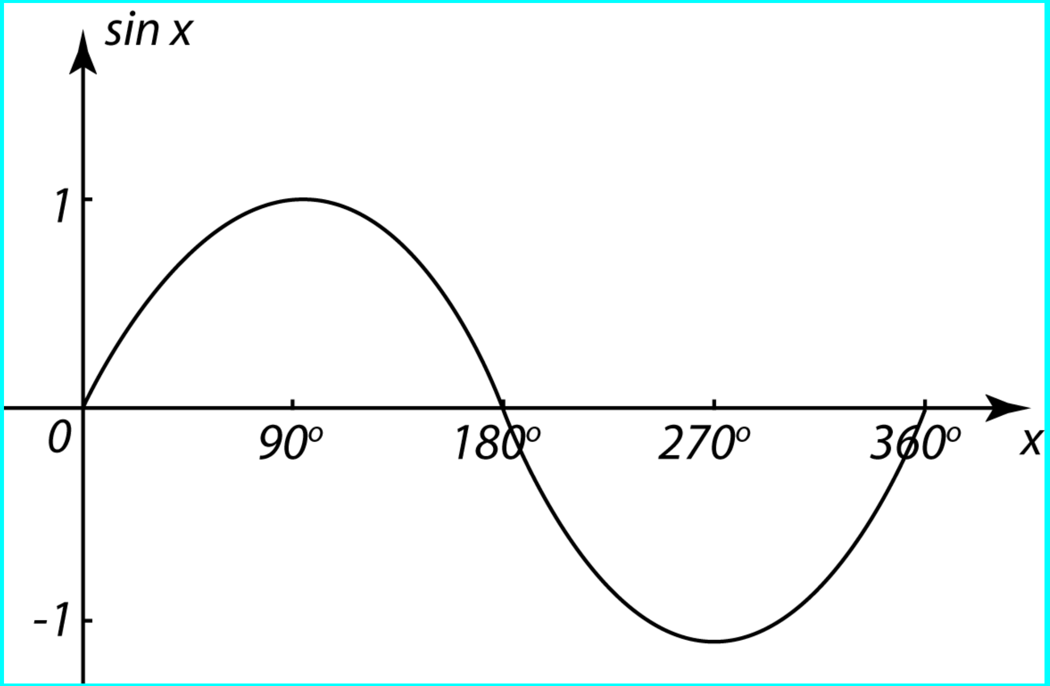
iClicker

- We will start using iClicker cloud next week.
- Go to www.iclicker.com and “Create an account”



Sine/cosine waves

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



Math of Waves

What is the period of

$$y = A\sin(kx + \omega t)$$

(A) $T = 2\pi$

(B) $T = \pi$

(C) $T = \frac{\omega}{2\pi}$

(D) $T = \frac{2\pi}{\omega}$

Math of Waves

What is the wavelength of

$$y = A\sin(kx - \omega t)$$

(A) $\lambda = \dfrac{v}{f}$

(B) $\lambda = \dfrac{\omega}{k}$

(C) $\lambda = \dfrac{2\pi}{k}$

(D) $\lambda = \dfrac{2\pi}{kv}$

Ch 16: 120 (like 40, 41)

A radio station broadcasts at 101.7 MHz. What is the wavelength of the waves?

Identify: The gave us f and asked λ

Did they give v? Yes … v = c

Develop: $v = f\lambda$

Execute:

Assess:

Ch 16: 73b (like 47, 48)

A sinusoidal wave travels down a taut horizontal string
With linear mass density $\mu = 0.06\,kg/m$
The maximum vertical speed is $v_{y_{max}} = 0.30\,cm/s$

The wave equation is $y(x,t) = A\sin(\frac{6.00}{m}x - \frac{24}{s}t)$

What is v_x?

Identify: Can we calculate v_x?

Develop: $v_x = \frac{\omega}{k}$ $\quad y(x,t) = A\sin(kx - \omega t)$

Execute:

Assess:

Ch 16: 73b (like 47, 48)

A sinusoidal wave travels down a taut horizontal string
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The wave equation is $y(x,t) = A\sin\left(\frac{6.00}{m}x - \frac{24}{s}t\right)$

What is v_x?

Develop:

Execute:

Assess:

Ch 16: 73a (like 72)

A sinusoidal wave travels down a taut horizontal string
With linear mass density $\mu = 0.06\,kg/m$
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The wave equation is $y(x,t) = A\sin(\frac{6.00}{m}x - \frac{24}{s}t)$

What is A?

Is there a relation between v_y and A?

Develop: $v_y = \frac{dy}{dt}$ $y(x,t) = A\sin(kx - \omega t)$

Execute:

Assess:

Ch 16: 73a (like 72)

A sinusoidal wave travels down a taut horizontal string
With linear mass density $\mu = 0.06\,kg/m$
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The wave equation is $y(x,t) = A\sin\left(\frac{6.00}{m}x - \frac{24}{s}t\right)$

What is A?

Is there a relation between v_y and A?

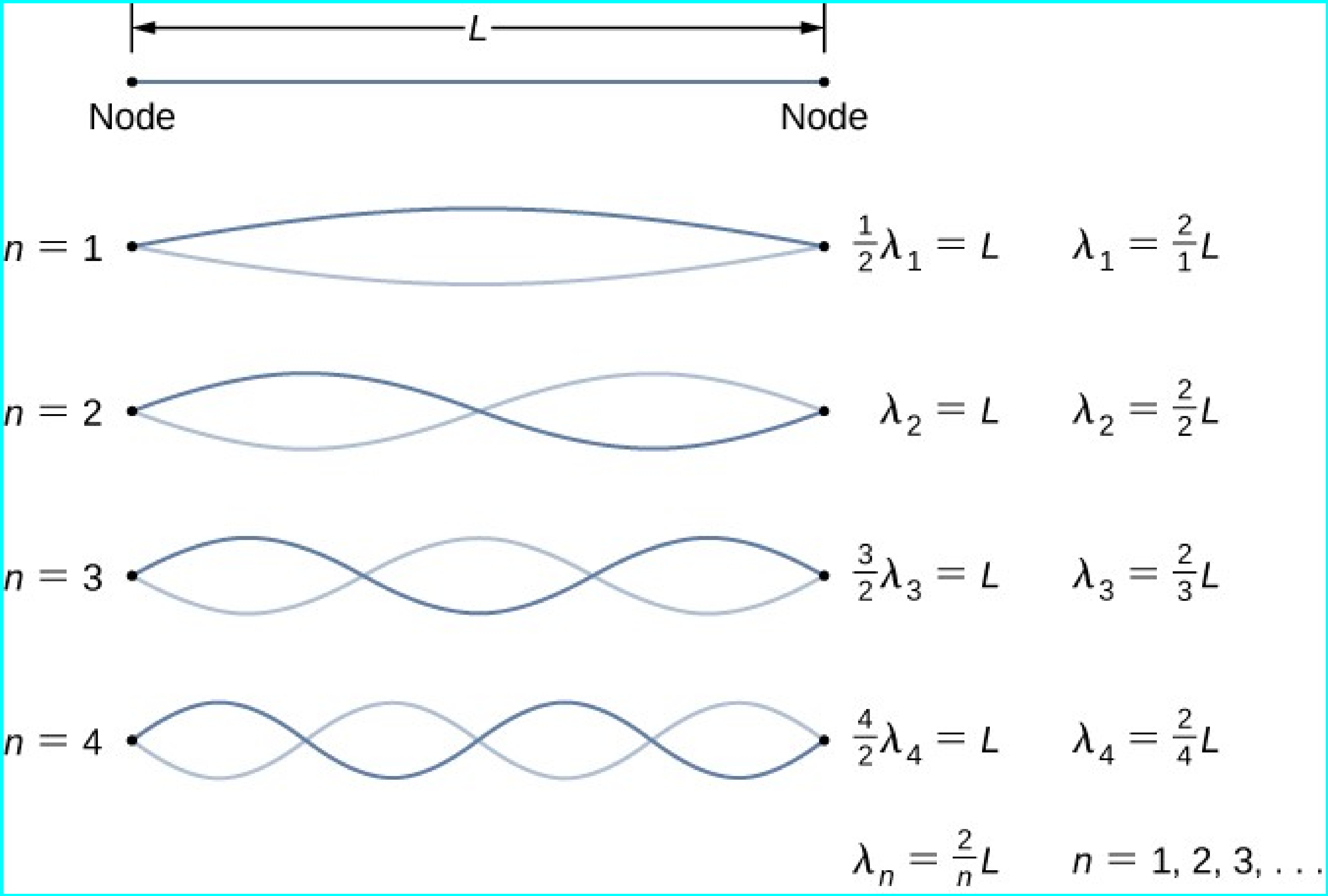
Develop:

Execute:

Assess:

Standing Waves

If you create a wave with fixed ends, it can only have certain wavelengths



Why are they “standing”

They don’t appear to be moving left to right … they just oscillate up and down.

They can be made by adding a wave traveling left to a wave traveling right.

Ch 16: 104 (like 103)

$L = 2\,m \quad \mu = 6\,g/m \quad m = 2\,kg$

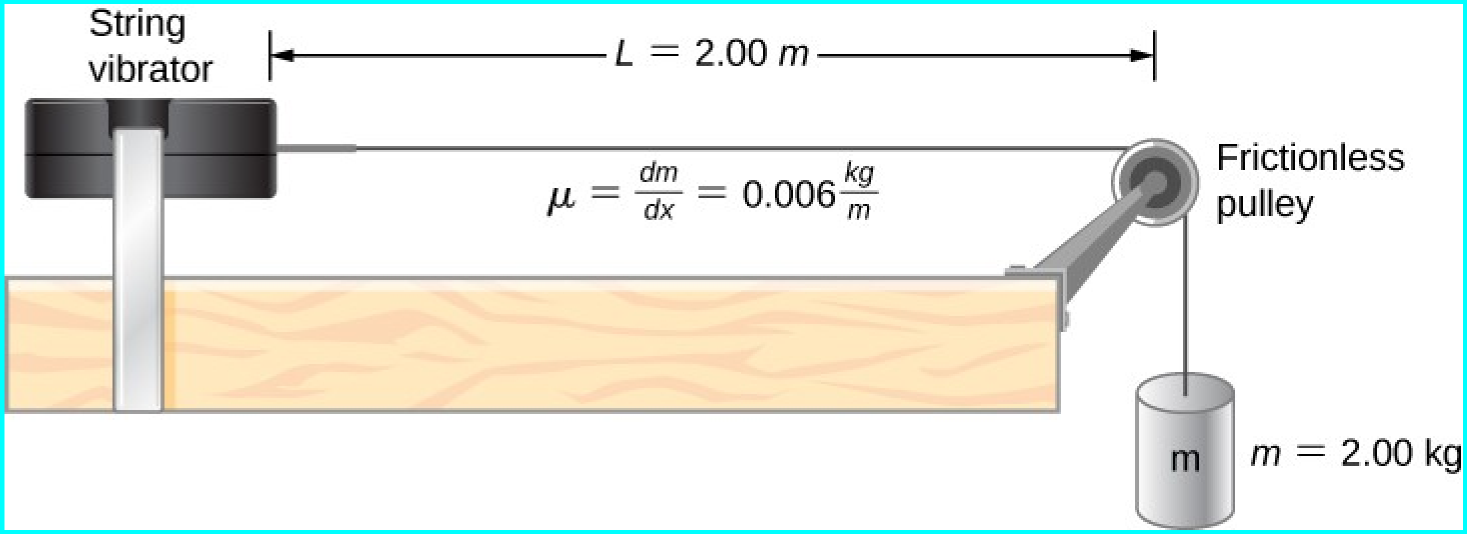
What are λ and f for n=6?

Identify: What the heck is n=6?

Develop:

Execute:

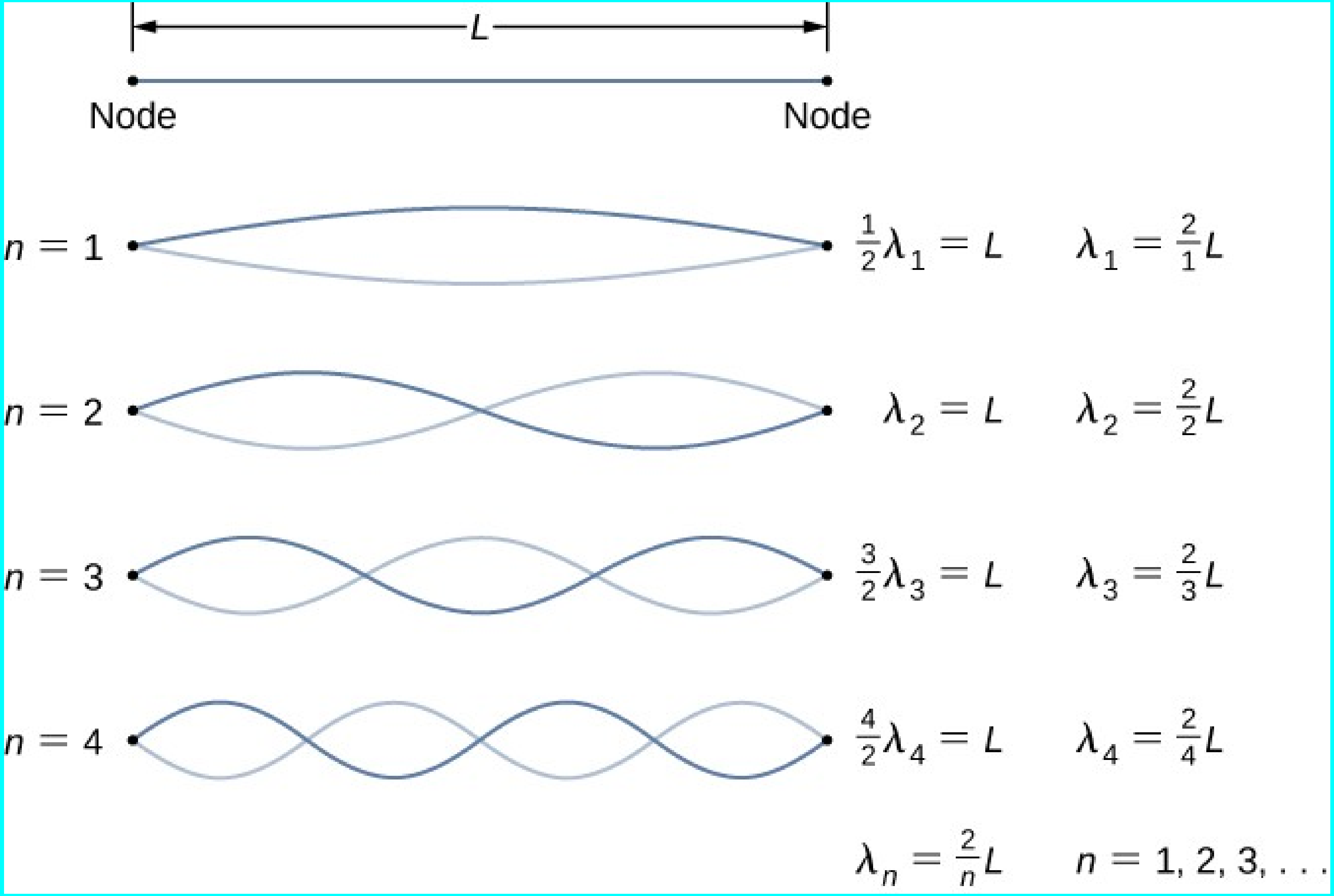
Assess:



Ch 16: 104 (like 103)

$L = 2\,m \quad \mu = 6\,g/m \quad m = 2\,kg$

What are λ and f for n=6?



Ch 16: 104 (like 103)

$L = 2\,m \quad \mu = 6\,g/m \quad m = 2\,kg$

What are λ and f for n=6?

Identify: What the heck is n=6?

Develop: $\lambda_6 = \frac{2}{6} L$

Execute:

Assess:

pHeT time?

Key Equations

Wave speed	$v = \frac{\lambda}{T} = \lambda f$
Linear mass density	$\mu = \frac{\text{mass of the string}}{\text{length of the string}}$
Speed of a wave or pulse on a string under tension	$\lvert v \rvert = \sqrt{\frac{F_T}{\mu}}$
Speed of a compression wave in a fluid	$v = \sqrt{\frac{B}{\rho}}$
Resultant wave from superposition of two sinusoidal waves that are identical except for a phase shift	$y_R(x, t) = \left[2A \cos\left(\frac{\phi}{2}\right)\right] \sin\left(kx - \omega t + \frac{\phi}{2}\right)$
Wave number	$k \equiv \frac{2\pi}{\lambda}$
Wave speed	$v = \frac{\omega}{k}$

A periodic wave	$y(x,t) = A\sin(kx \mp \omega t + \phi)$
Phase of a wave	$kx \mp \omega t + \phi$
The linear wave equation	[redacted]
Power averaged over a wavelength	$P_{\text{ave}} = \frac{E_\lambda}{T}$ [redacted] $\mu A^2 \omega^2 v$
Intensity	[redacted]
Intensity for a spherical wave	[redacted]
Equation of a standing wave	$y(x,t) = [2A\sin(kx)]\cos(\omega t)$
Wavelength for symmetric boundary conditions	$\lambda_n = \frac{2}{n}L, \quad n = 1, 2, 3, 4, 5...$
Frequency for symmetric boundary conditions	$f_n = n\frac{v}{2L} = nf_1, \quad n = 1, 2, 3, 4, 5...$

Next Class:

Introduction to charge and Coulomb's law