Boğaziçi University

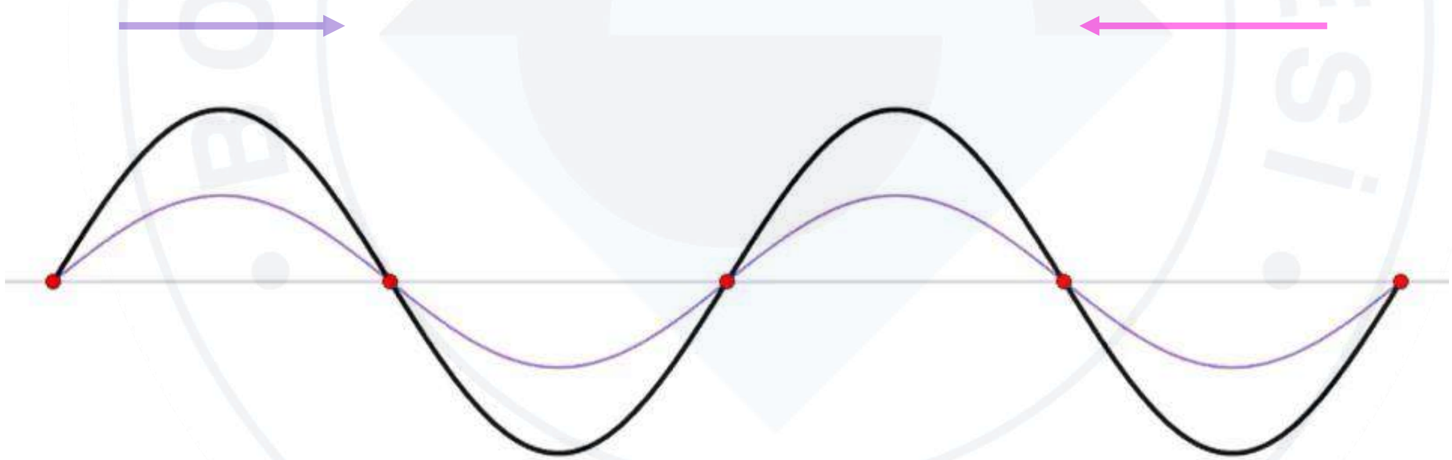
Introductory Phys Labs

STANDING WAVES IN A STRING

PHYL102

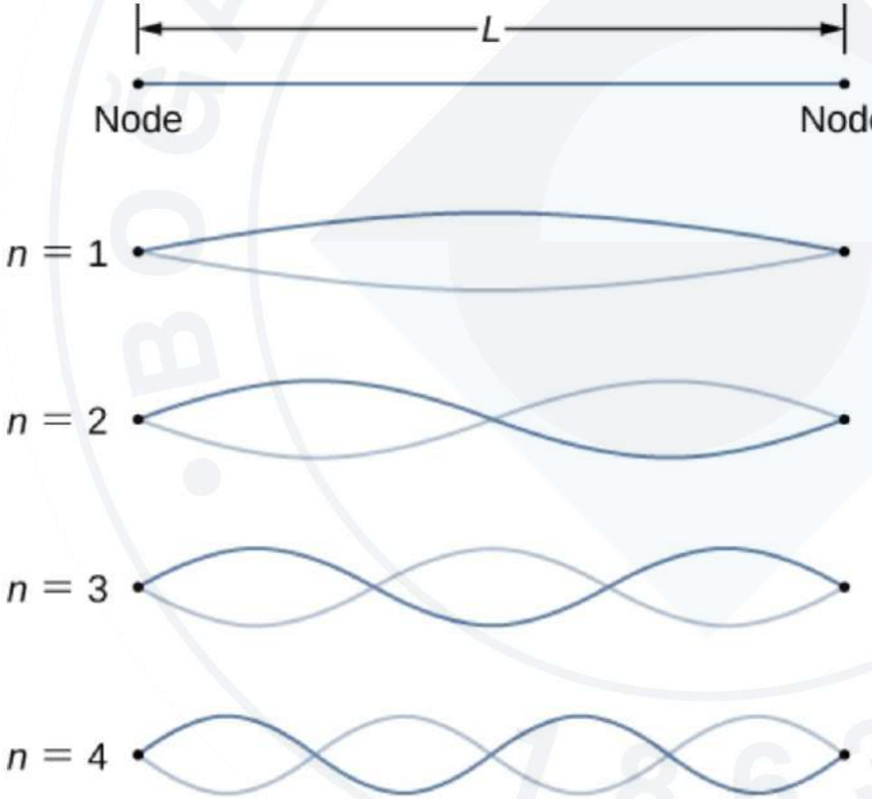
STANDING WAVES IN A STRING

Standing waves are a type of resonance that occurs when waves interfere and produce pattern which occurs as incident waves constructively interfere with reflected waves. The points where the string is motionless are called ***nodes*** **.**



STANDING WAVES IN A STRING

If the length remains unchanged, standing waves only occur at specific frequencies. We have strings with nodes at both ends, which produces the following



$\frac{1}{2}\lambda_1 = L \qquad \lambda_1 = \frac{2}{1}L$

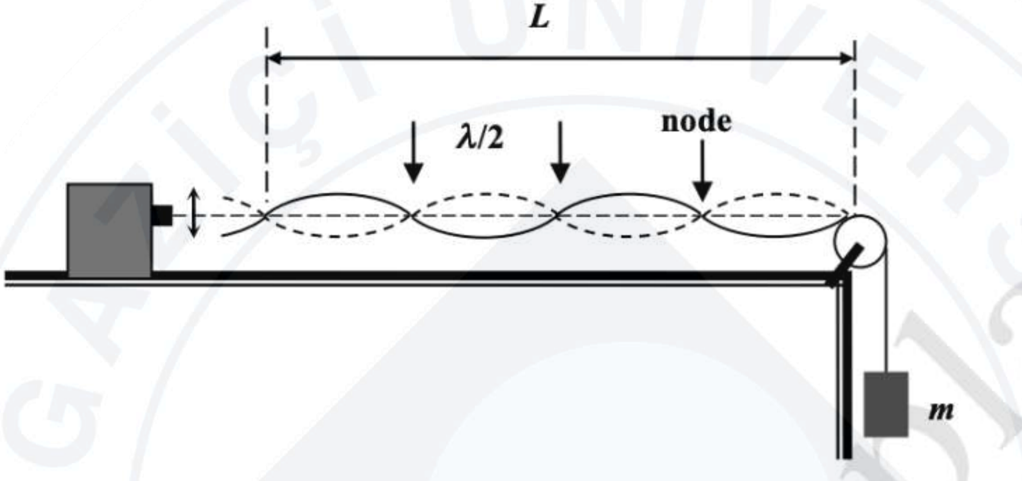
$\lambda_2 = L \qquad \lambda_2 = \frac{2}{2}L$

$\frac{3}{2}\lambda_3 = L \qquad \lambda_3 = \frac{2}{3}L$

$\frac{4}{2}\lambda_4 = L \qquad \lambda_4 = \frac{2}{4}L$

$\lambda_n = \frac{2}{n}L \qquad n = 1, 2, 3, \ldots$

THEORY



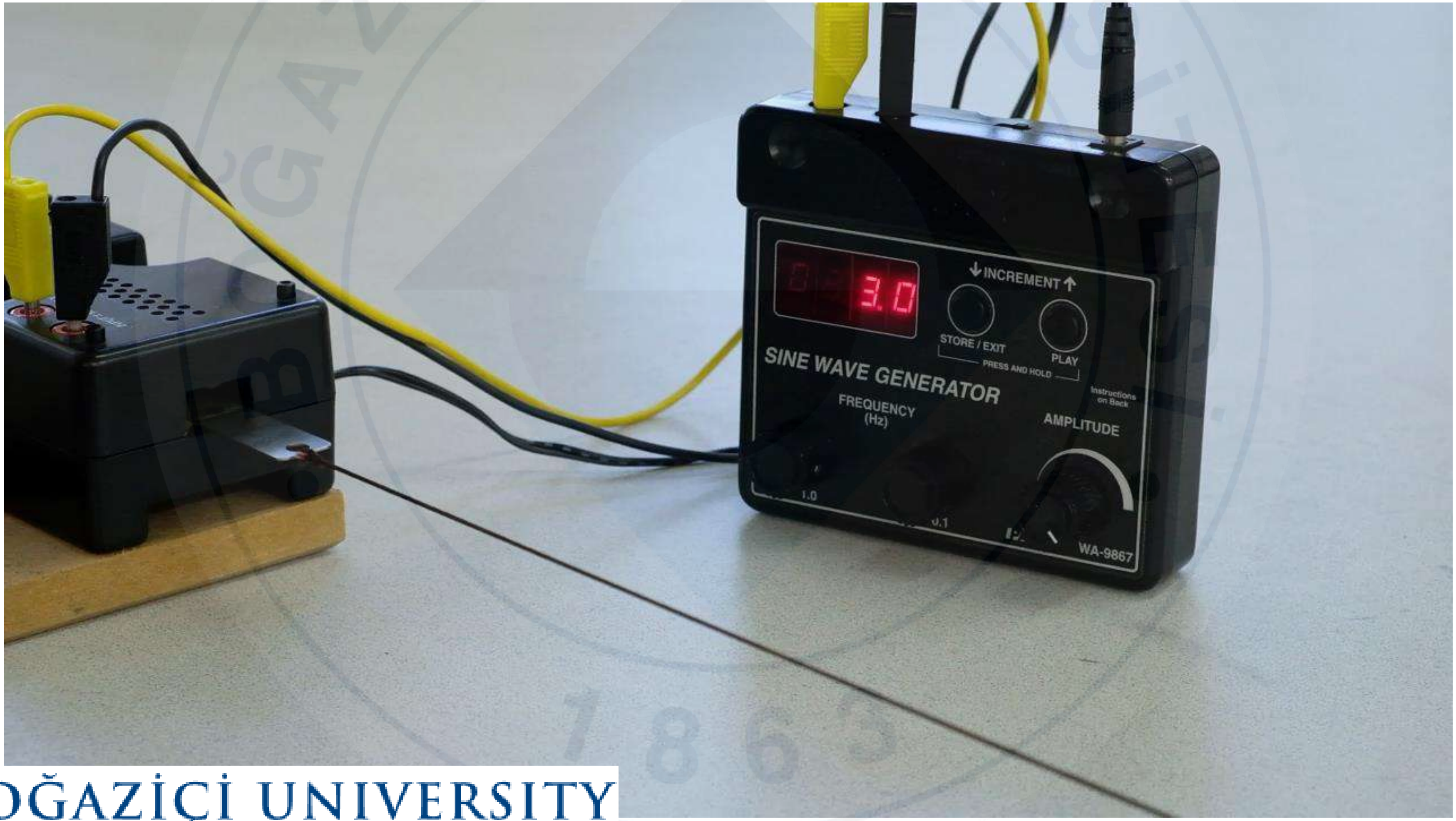
The wavelength of the waves travelling along the string with speed ***v*** depends on the tension **T** and mass per unit length of the string ***μ*** . Tension is created by hanging mass **m .** Tension **T** is equal to **mg.**

$$v = \sqrt{\frac{T}{\mu}} = f\lambda$$

$$T = \mu\lambda^2 f^2$$

APPARATUS

Waves in the string is created by string vibrator



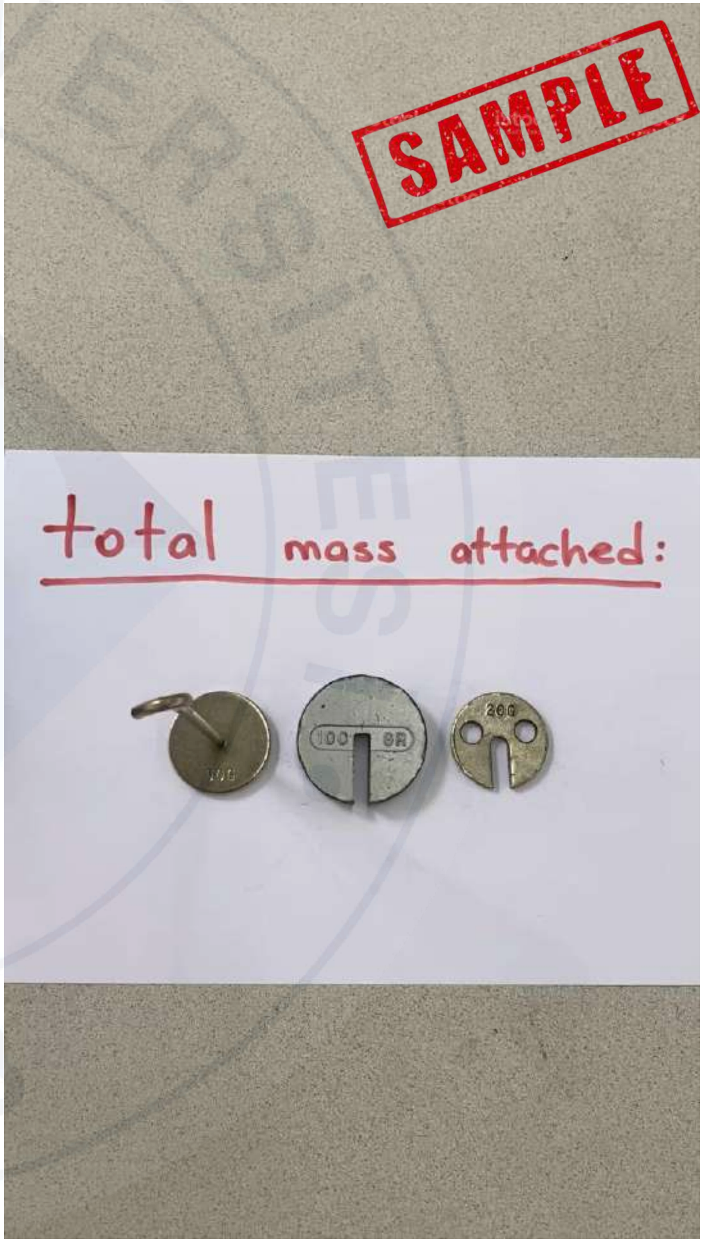
EXAMPLE OF STANDING WAVES

- Place a mass on the mass holder.
  T = mg

- Arrange the frequency of the vibration generator until standing wave is clearly observed.

- Measure the length of the string from the node marked as 1 to the pulley in order to calculate wavelength.

$$T = \mu \lambda^2 f^2$$



EXPERIMENT

OBJECTIVE:

to observe standing waves and determine the mass per unit length μ of the string.

$$v = \sqrt{\frac{T}{\mu}} = f\lambda$$

$$y = mx$$

$$T = \underbrace{\mu\lambda^2}\, f^2$$

A plot of the tension **T** versus **f²** data pairs that produce standing waves should follow a straight line whose slope is equal to $\mu\lambda^2$ .Tension **T** on the string is provided by the masses placed on the hanger on the other hand. **T = mg**

- **What to measure**: Hanging mass **m**, length of the cord **L**, number of half wavelengths $\frac{\lambda}{2}$, frequency of the standing wave **f**
- **What to calculate:** Tension **T = mg ,** wavelength λ
- **Experimental findings :** Mass per unit length μ

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PROCEDURE:

$$T = \underbrace{\mu\lambda^2}f^2$$

- Produce a tension on the string by hanging masses to one end. **T = mg**

- Arrange the frequency of the wave generator until standing wave is clearly observed.

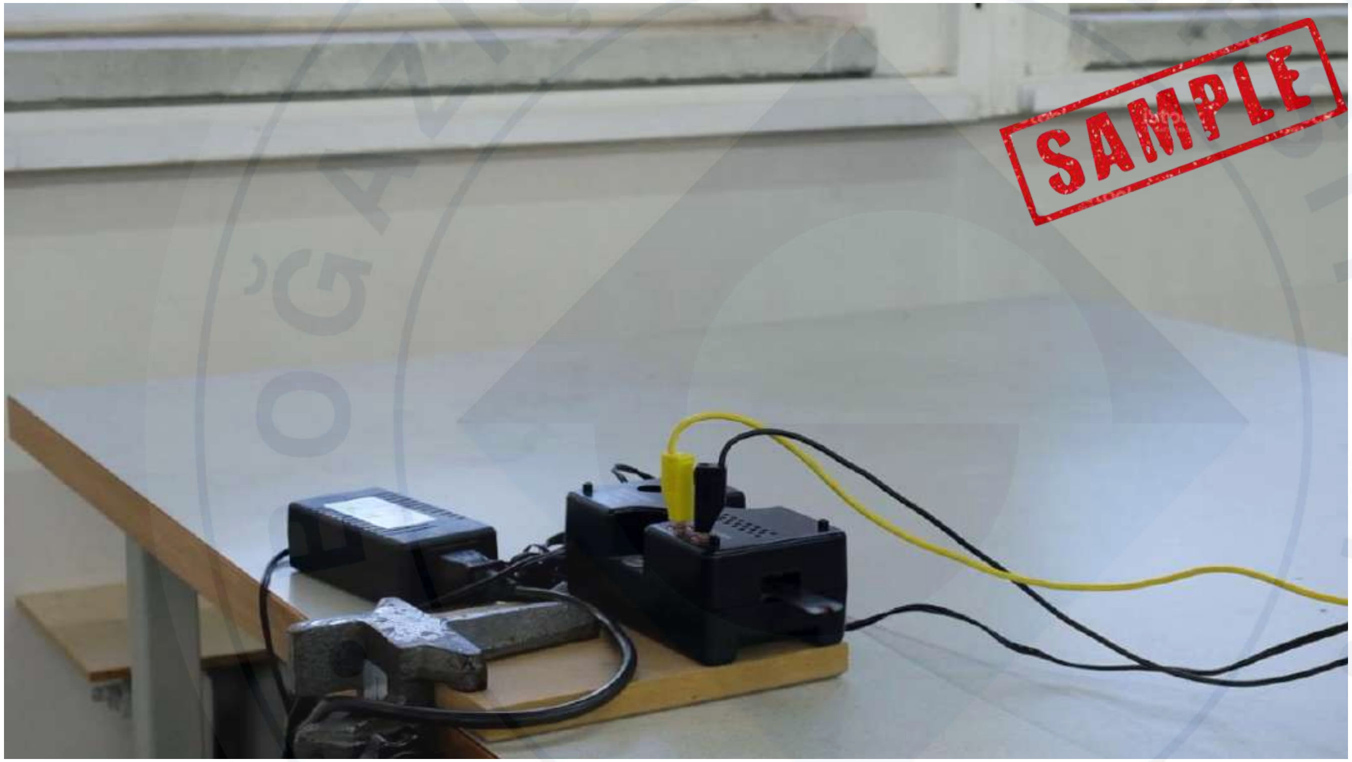
- Mark the position of the first node of standing wave on the string.

- Measure the length **L** of the string from the first node to the turning point of the pulley. Count the number of half wavelengths in **L**. Determine the wavelength.

- Record the frequency value along with the corresponding mass on the holder.

- By keeping the **wavelength constant**, change the mass and read the corresponding frequency for clearly observed standing waves for **4 more times.**

EXAMPLE



$T_1 = m_1 g \rightarrow f = f_1$

$T_2 = m_2 g \rightarrow f = f_2$

$T_3 = m_3 g \rightarrow f = f_3$

$T_4 = m_4 g \rightarrow f = f_4$

$T_5 = m_5 g \rightarrow f = f_5$

λ = constant

$$T = \underbrace{\mu\lambda^2}f^2$$

STANDING WAVES IN A STRING

Take the data and fill in the page

Description / Symbol			Value & Unit	
Mass per unit length of the Cord	μ_{TV}	=	....	....
Length of the Cord	L	=	....	....
Acceleration due to gravity	g	=	981 cm/s^2	....

Length of the Cord L is from the first node until the pulley

Mass, m ( )	# of λ / 2 (keep constant)	λ ( ) (keep constant)	Frequency, f ( )	f^2 ( )	Tension $T = m.g$ ( )

STANDING WAVES IN A STRING

- Plot tension T vs f^2

(Scale your axes such a way that your graph covers whole paper)

- Choose two points on the line

$$T = \underbrace{\mu\lambda^2}f^2$$

- Determine slope

Slope = $\mu\lambda^2$

Find μ

A) **From the graph, choose two SLOPE POINTS other than data points,**

SP_1 : (;)

SP_2 : (;)

B) **Calculate:**

SLOPE = ...

RESULTS:

Description / Symbol	Calculations (show each step)	Result
Mass per unit length of the Cord μ_{EV} =	....	....
	....	
% Error for μ =	....	....

Dimensional analysis for μ : ....