stationary waves

منتدي روضة العلوم الطبيعية

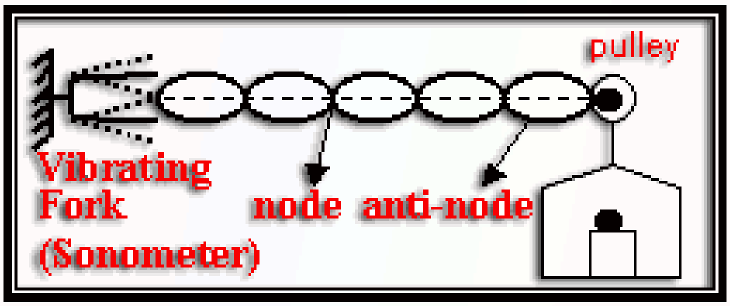
1 - The transverse standing wave : -

Those waves are obtained as a superposition of two waves, they have:

1- Same frequency.

2- Same amplitude.

3- Same speed.



-٤Opposite in direction.

Where you will observe- :

Node	Anti-node
Where the resultant amplitude equals zero.	Where the resultant amplitude is max.

Wave length of standing wave- :

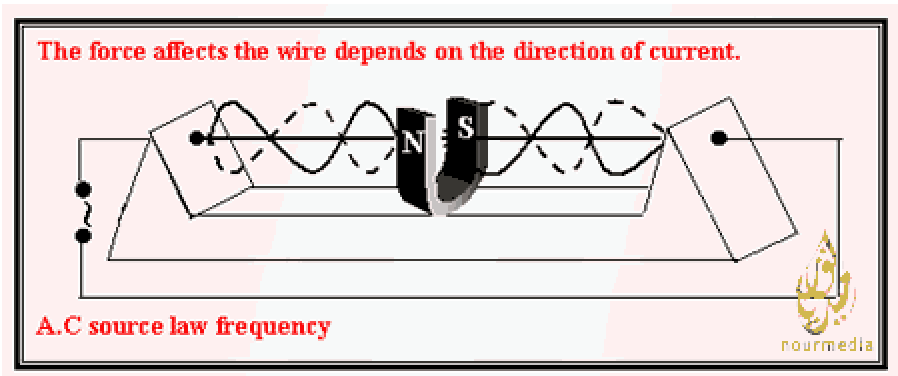
DEFINITION- :

Is twice the distance between two successive nodes or two successive anti-nodes.

Meld's exp. To demonstrate standing wave- :

The apparatus: sonometer as shown in figure.

- When the tuning fork vibrates a wave train travels until it reaches the pulley. Then reflects from it. The incident and reflected waves superimpose forming standing waves consists of nodes and anti-nodes.
- When the tension increases (at const. Frequency (
- Number of segments decrease
- Wave velocity increase
- But wavelength increase



Vibrating string- :

Introduction- :

1) Both ends must be nodes because the ends of the string are fixed.

The velocity of propagation of the transverse wave in a stretched string (٢

$$\left(\sqrt{\frac{T}{m}}\right) = \qquad V$$

3) Where: T is the tension of the spring

4)) T = m` . g) where m´ the weight in the scale pair.

m is the mass per unit length for the string where

$$m = \frac{Total \text{ mass of the string}}{Lenght \text{ of the string}}$$

m/s unit is Kg'it

$$٢r\ rp = \frac{\rho\,\pi r^2 L}{L} = \frac{\rho\, V}{L} = \frac{m_{total}}{L} = m$$

$$٢r\ rp = m$$

r .density of the string r its radius

:Number of segments depends on the tension (٤

- :The fundamental Tone -a

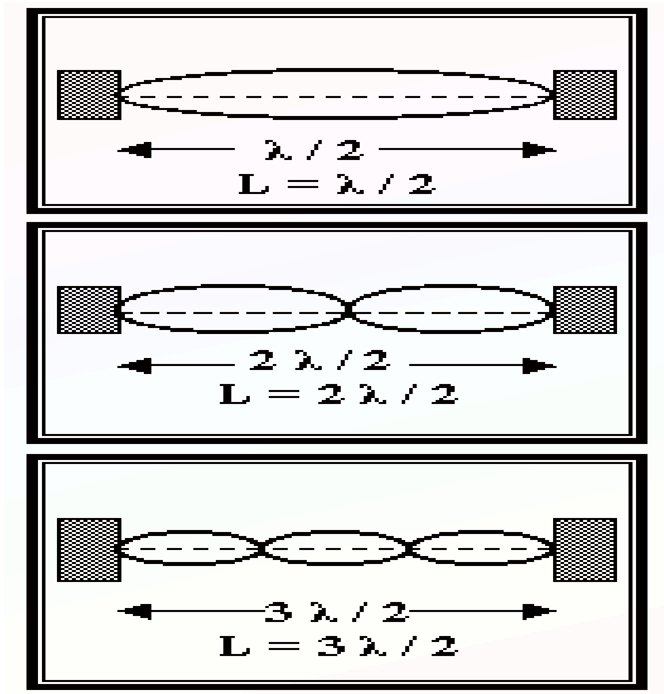
When the vibrating string forms one
It emits its fundamental tone .segment
whose frequency is the smallest
possible frequency on the vibrating
.string

- :The First Harmonic Tone -b

٢When vibrating string form
.segments by increasing the tension
The .It emits its first harmonic tone
frequency of the first harmonic is
.twice the frequency of the fundamental

- :The Second Harmonic Tone -c

The string vibrates in the form of
.d harmonicthree segments and emits its secon
Its frequency is three times the
.frequency of the fundamental



and wave (n)number of segments ،(L)The relation between the length

- :(l) length

(General law of strings)

$$L = \frac{n\lambda}{2}$$

$$l = \frac{2L}{n}$$

But $V = l \; . \; g$

But $V = \sqrt{\frac{T}{m}}$

$$\upsilon \times \frac{2L}{n} = \sqrt{\frac{T}{m}}$$

$$\upsilon = \frac{n}{2L} \times \sqrt{\frac{T}{m}}$$

When n=١ he string emits its fundamental tone with T .frequency

When n=٢ .The frequency of the first harmonic

When n =٣ .The frequency of second harmonic

- :Note

:The ratio between frequencies -١

$u_٠ : u_١ : u_٢ : u_٣ : ......$

$١ : ٢ : ٣ : ٤ : ......$

.The factors affecting the fundamental frequency of a stretched string -٢

$$u = \frac{n}{2L}\sqrt{\frac{T}{m}}$$

Length	Tension	mass per unit length
$u \ \alpha \ \frac{1}{L}$	$u \ \alpha \ \sqrt{T}$	$\upsilon \alpha \frac{1}{\sqrt{m}}$

$$\frac{\upsilon_1}{\upsilon_2} = \frac{L_2}{L_1} \qquad \frac{\upsilon_1}{\upsilon_2} = \sqrt{\frac{T_1}{T_2}}$$

٣- m = rp r٢

$$\frac{\upsilon_1}{\upsilon_2} = \sqrt{\frac{\rho\pi r_2^2}{\rho\pi r_1^2}} = \frac{r_2}{r_1}$$

.for the same material

and diameter affect the frequency because m depends on Both density
.them

- : (١)Example

N and its mass per unit ٤٠٠ =A stretched string is stretched by a force
Then .Find the velocity of a sound wave through it .Kgm ٠,٠٠٠١ =length
over tone rd٣find its length if it is
.Hz ٤٠٠٠ =has a frequency

- : Solution

$$\text{s /m ٢٠٠٠} = \frac{20}{0.01} = \sqrt{\frac{400}{0.0001}} = \sqrt{\frac{T}{m}} = V$$

$$\text{m ٠,٥} = \frac{2000}{4000} = \frac{V}{\upsilon} = \backslash\ \lambda \qquad \upsilon\,\lambda = V$$

$$\text{m ١} = \frac{4x0.5}{2} = \frac{n\lambda}{2} = L\ \backslash \qquad \frac{2L}{n} = \lambda$$

- : (٢)Example

Compare between the frequency of two stretched strings the ratio between
r tension isthe ratio between thei ،١ : ٢their lengths is
when they ٤ : ١and the ratio between their mass per unit length is ١ : ٩

.emit the fundamental music note

- : Solution

$$\frac{\upsilon_1}{\upsilon_2} = \frac{\frac{1}{2L_1}\sqrt{\frac{T_1}{m_1}}}{\frac{1}{2L_2}\sqrt{\frac{T_2}{m_2}}}$$

$$= \frac{L_2}{L_1} \text{ x } \sqrt{\frac{T_2}{T_1}} \text{ } x \sqrt{\frac{\text{m}_2}{\text{m}_1}}$$

$$\frac{\upsilon_1}{\upsilon_2} = \frac{1}{2} \times \sqrt{\frac{9}{1}} \times \sqrt{\frac{4}{1}}$$

$u_{١} : u_{٢}$ = ٣ : ١